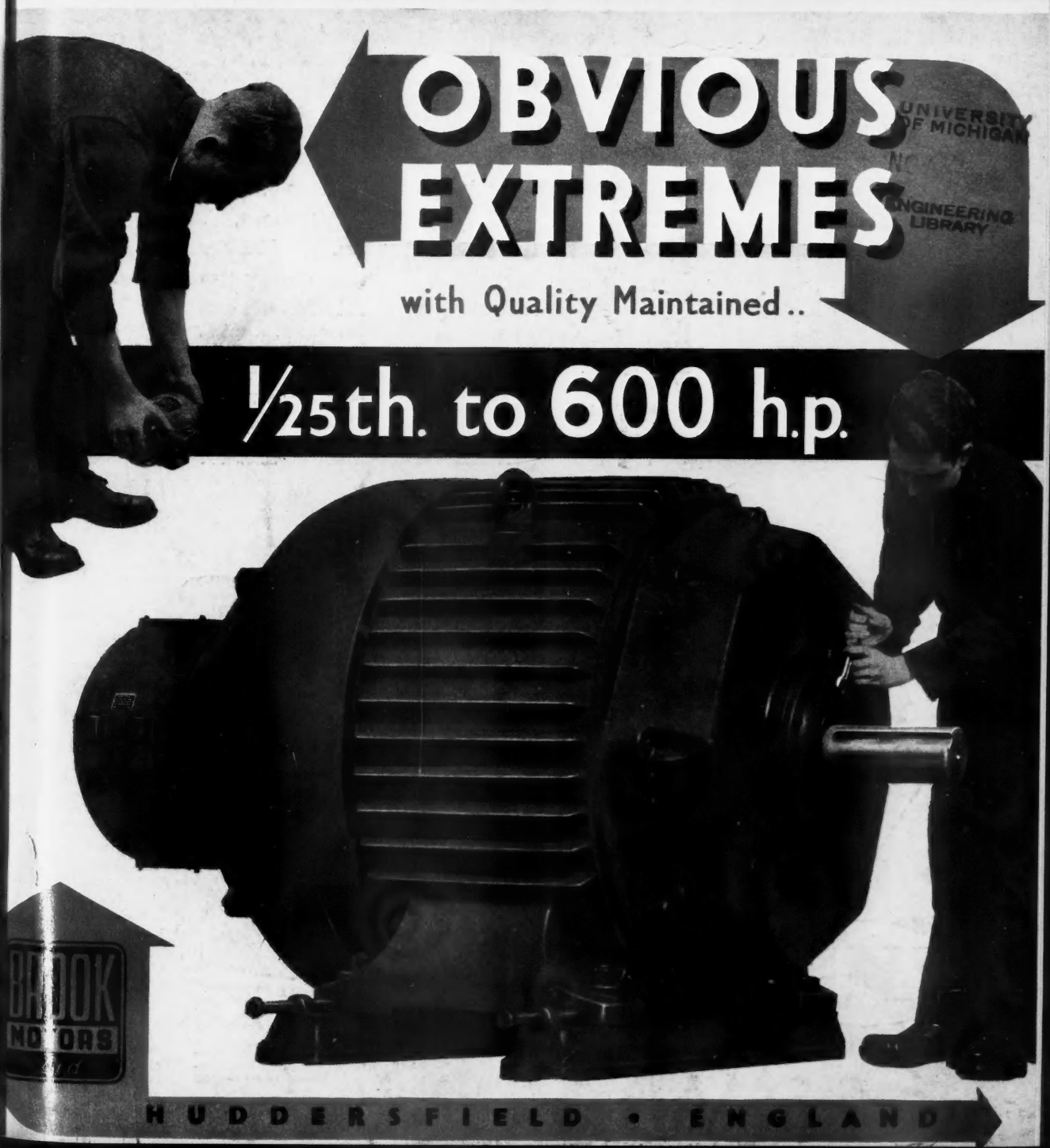
ELECTRICAL REVIEW



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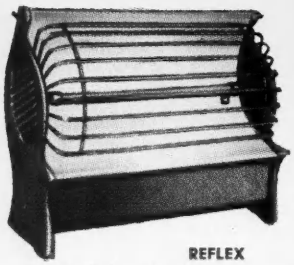

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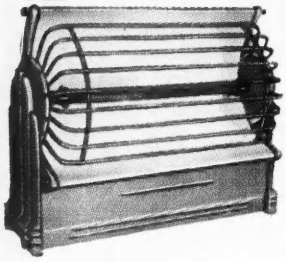

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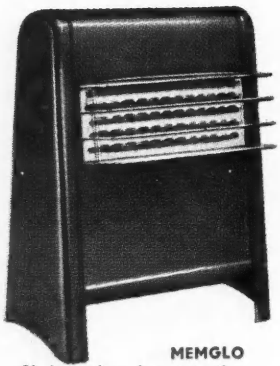

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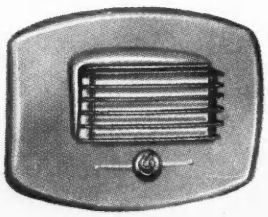

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ELECTRICAL REVIEW

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9 NOVEMBER 1956

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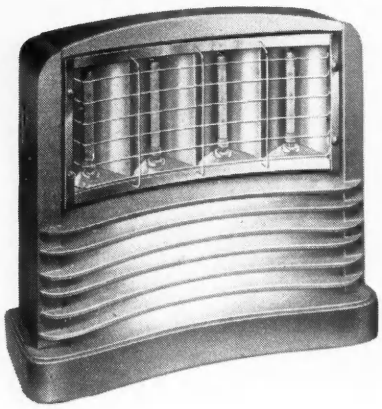

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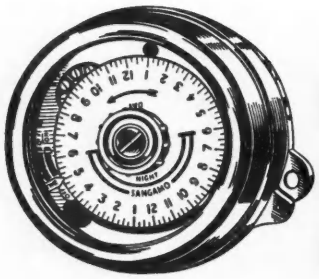

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ELECTRICAL REVIEW

9 November 1956 Vol. 159 No. 19 Established 1872

Factory Inspection

IT was as long ago as 1928 that the organisation and work of the Factory Inspectorate was last reviewed. Changes in conditions, both quantitatively and in the shape of higher standards, since that date have been so great that the recent White Paper on the subject* was really necessary. Actually between 1928 and 1955 there was a fall in the total number of factories from 261,581 to 231,477, but those with power increased from 149,532 to 213,822; the loss was in factories without power which declined in number from 112,049 to only 17,644. It is pointed out in the White Paper that the work in inspecting a "non-power" factory is substantially less than in "power" factories. Electricity regulations were in force in about 100,000 of the 1928 factories; nowadays practically all factories must be subject to them.

All regulations add to the Inspectorate's work and further additions will be made by codes now in contemplation including ionising radiation regulations and new regulations for lighting which will extend the existing requirements to all factories and introduce requirements relating to exterior lighting.

The establishment now totals 378 of whom 322 are in the General Inspectorate and the rest (including 14 electrical inspectors) in the specialist branches. Although it is said that there is a dearth of new inspectors with technical qualifications this does not appear to apply to the specialist branches (with the exception of the Medical Branch) which are reported to be up to strength. For the Electrical Branch candidates have to be 35 years of age or over and must be corporate members of the I.E.E. with several years of electrical experience. Responsible experience in large electricity supply undertakings or electrical manufacturing works has always carried special weight and continues to do so.

In comparison with other specialist branches the work of the Electrical Branch consists much more in routine inspection, but rather more than a third of the electrical inspectors may be regarded as specialists by reason of their particular training and experience and they sometimes assist their colleagues on the larger problems arising within their special branch of electrical work. Recent field work by the Electrical Branch has included investigations into soil resistivity and earthing in certain areas. Other subjects investigated have been safety precautions in the construction and design of high-frequency furnaces and the safety design of instruments for the gas industry. The branch is also responsible for the annual publication "Electrical Accidents and their Causes."

It is considered in the White Paper that few changes in the organisation of the Factory Inspectorate are necessary but a number of proposals are made for certain

* "Staffing and Organisation of the Factory Inspectorate" (Cmd. 9879), H.M. Stationery Office, price 2s.

adjustments. There is thought to be a need for trebling the Engineering and Chemical Branch and partially decentralising it. The staff of this branch is recruited by promotion from the general inspectorate, unlike the electrical inspectors who are recruited directly from outside. While there is no doubt a good case for strengthening the Engineering and Chemical Branch, it seems strange that nothing is said about enlarging the Electrical Branch which has only two more inspectors now than were recommended in 1928.

EUROPEAN FREE TRADE

Until all the implications of the proposals that this country should join with six Continental countries to form a partial free trade area can be ascertained British manufacturers are naturally hesitant to give definite opinions on the subject. After a necessarily hurried inquiry among its member associations and firms the Federation of British Industries has presented a somewhat indeterminate report to the President of the Board of Trade.

An analysis of the replies received from the Federation's members shows that there is no out-and-out acceptance of the proposals. Nevertheless the majority are willing to support negotiations (or will not oppose them) provided adequate safeguards are worked out. These safeguards are directed against possible unfair methods of competition by the European partners in any such scheme as this and against anything likely to weaken the bonds between Great Britain and Commonwealth countries. Another matter in which British manufacturers might find themselves at a disadvantage is the excessive taxation they have to bear which adds considerably to their price levels. It remains to be said that electrical and allied manufacturers are generally in favour of negotiations, although some of them are opposed to negotiations unless certain safeguards are assured, apparently in advance.

THE PROFESSIONAL ENGINEER

" A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in the education of the engineer." These are the first two sentences of a fairly lengthy definition of the professional engineer adopted by EUSEC (Conference of Representatives from the Engineering Societies of Western Europe and the United States of America) for the purposes of conference discussion.

In recent years all sorts of professional, educational and industrial organisations have attempted definitions of the term " professional engineer " and the result has been confusion. In his inaugural address Professor G. H. Rawcliffe, chairman of the Western Centre of the Institution of Electrical Engineers (see page 866), said that professional engineering was a curiously blended mixture of science, technology and administration, and that no one of these qualifications would avail anything without an adequate mixture of the other two. If not exactly a definition, this is a good specification for the make-up of the professional engineer.

INDIAN STEELWORKS CONTRACT

Particulars are given in page 862 of this issue of the contract which forms the subject of an agreement signed last week by the Government of India and the Indian Steelworks Construction Co., Ltd., a consortium of British contractors and manufacturers, for the erection of a large steelworks at Durgapur. Altogether equipment to the value of £50 million will be supplied from this country and a substantial part of it will be electrical plant. There will be a power station with three 5,000 kW sets, four 10,000 h.p. turbo-blowers, many large mill-driving motors, transformers and other associated electrical gear as well as diesel-electric locomotives and a comprehensive lighting installation. Four of the largest British electrical manufacturers will carry out the bulk of the work but there is also scope for others.

The Durgapur contract gives a great opportunity to British concerns to show what they can do in competition with those of other countries. Russia and Germany are also in this field, having secured contracts for other steelworks in India. Much depends on finance for which satisfactory arrangements have been made in this case.

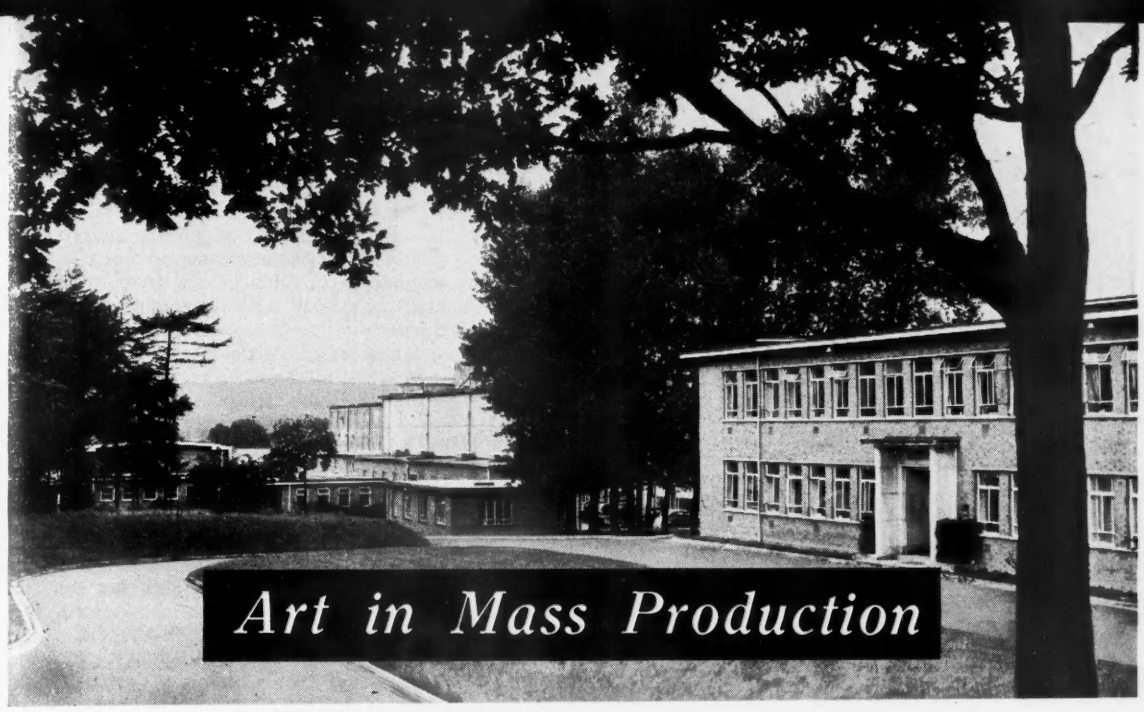
DOMESTIC HEAT PUMPS

In his article on this subject in this issue, Mr. B. Z. de Ferranti shows fairly clearly that the domestic heat pump can now be regarded as a likely commercial proposition from the purely manufacturing point of view. He does not, however, tell us a great deal about the economics of the development from the installation angle. True, he makes a good case for running costs which look very favourable against those for the domestic refrigerator, but very little is said about the initial or capital costs.

These initial costs are not generally sized up, together with running costs, by domestic consumers as they are in the case of a piece of industrial eqiupment, because the equipment is bought mainly for its convenience and service. An earlier view of the domestic heat pump was that where the initial cost, including installation, could be buried in the price of a new house it was a likely proposition, but have we yet reached the stage when a heat pump can be installed and adapted to an existing house?

THERMAL STORAGE WATER HEATERS

Continuing our series of illustrated surveys of domestic electrical appliances, next week (16th November) we shall be dealing with thermal storage water heaters. Included in the particulars to be given in tabular form will be details of the type, capacity, loading, finish, price, purchase tax, etc. On 7th December immersion heaters will be reviewed



Art in Mass Production

Electrical Review 9 November 1956

The Wedgwood Pottery Works at Barlaston

To an engineer, perhaps the most fascinating aspect of a factory like that of Josiah Wedgwood & Sons at Barlaston, near Stoke-on-Trent, is the unique way in which modern production methods have been dovetailed into craft techniques, the origins of which are lost far in the past.

The company, which was founded in 1759, moved in 1769 to a works in rural surroundings at Etruria but heavy industrial development over the years in that area led to the planning of a new establishment. Work was actually put in hand on this new factory in 1938, and now it stands as a splendid looking example of modern factory construction, in delightful countryside a few miles south of Stoke-on-Trent.

The new works was conceived as an ultra-modern pottery with its own employees' village on garden lines not far away. To some extent this has been achieved, planning and architecture being in the hands of the consultants responsible for Welwyn Garden City. The full realisation of the concept has not been attained largely because of rising building costs for domestic premises which have led to a limitation at present on the size of the associated village. A small halt has been provided on the railway line near the works and convenient stopping trains enable many of the 1,700 or so workers to come by train. Many more come by bus from the city.

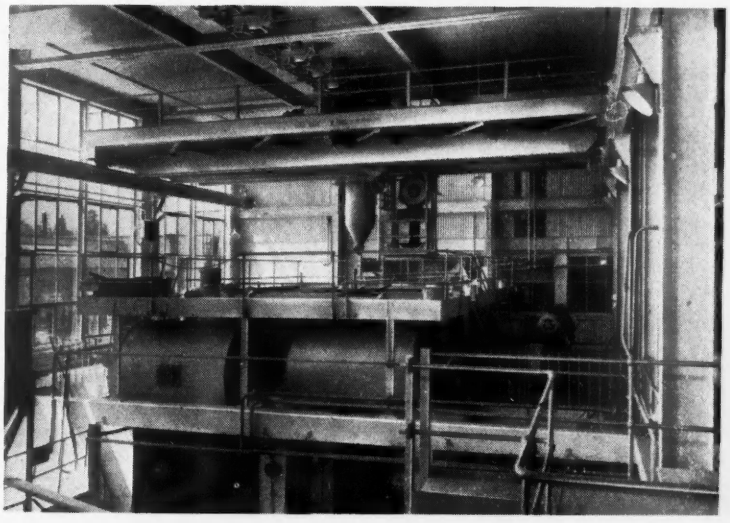
The works at the stage they had then reached were described in the *Electrical Review* in April, 1941, but since then many changes have taken place; in particular the electric tunnel kiln installation has been greatly increased.

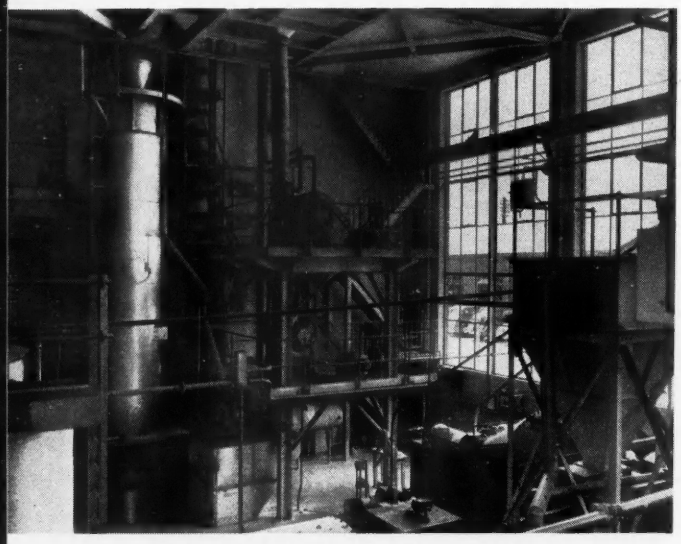
Earthenware and china production may for our purposes be divided into four stages. The first of these is the preparation of the raw materials into suitable "bodies" ready for turning into a particular class of product. The second is the shaping of the ware, the third the firing process and the last the decorating.

The principal raw materials of the industry, other than clay, are flint, felspar, stone and bone, and these are stored in basement bins fed direct from outside the building. In the roof of the preparation house are a series of storage hoppers. Quantities of each material are carried up to these bins by a bucket conveyor, travelling up one wall, across the roof storage hoppers, down the other side and back through the basement. It can thus have a wide variety of uses on a batch basis. Raw material from the roof hoppers is fed into the crane mounted hopper-weigher, from which the measured batch, if flint, is fed into a continuous Hardinge mill. This contains graded pebbles,

The heading illustration shows the Wedgwood Barlaston works in their rural surroundings.

Rotary ball-mills in the mill building. Outlets from storage hoppers are seen in the roof

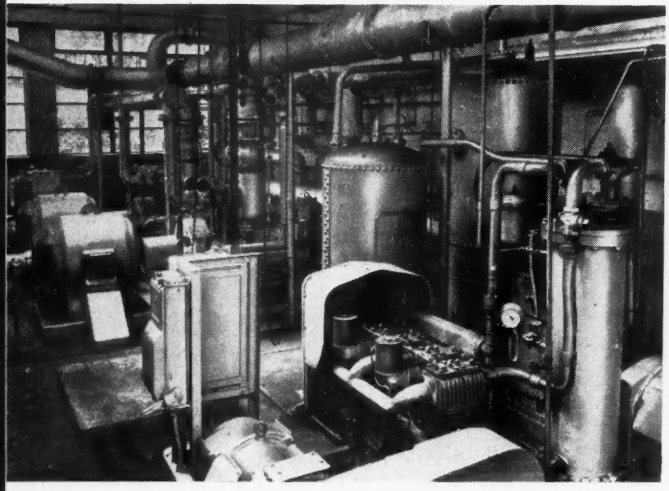




Calcining tower (left) and the Hardinge mill (right)

A range of drying ovens into which ware is placed as soon as it is made

Turbo-generator and compressor house



which steadily increase the fineness of the grinding as the wet slurry passes towards the small end of the cone. Materials other than flint are fed into the rotary batch type ball mills. Flint is calcined by passage down a gas-fired tower after being taken from the basement storage and before going into the roof hoppers.

From the mills the ground slurries are pumped to basement storage bins known as " arks." The raw clay is shovelled into " blungers " which beat up the stiff clay with water until a fine slurry is obtained, after which it passes through filters and into storage arks.

Treatment of " Body "

The various constituents of the actual " body " are " on tap " at a central batching point where the operator who is an experienced key man selects the constituents required for a particular china or earthenware " body." Each is then run in turn into a measuring tank which not only weighs out the quantity required but also measures the volume simultaneously. This enables the density and hence the weight of suspended solid in the mix to be checked. Push-buttons start up small pumps from the appropriate storage arks. The various constituents of a particular mix go to a " body " ark where they are kept continuously agitated by paddles.

When required the appropriate " body " is pumped through vibratory lawn filters and through electromagnetic filters. These particular filters are American Franz ferro filters and owe their success to the very great length of sharp edging incorporated in the construction of many layers of honeycombed metal. Each sharp edge represents a point of attraction for the fine magnetic particles which can spoil white ware when fired, by producing brown specks. The filters are cleaned out after the passage of each batch. The " body " then goes to presses where water is squeezed out, passing through another magnetic filter on the way into the press. Taken out of the press as flat sheets, it is put into pug mills which masticate the clay and extrude it in fine threads into a vacuum chamber running at about 28in of vacuum. This de-aerates it and makes for improved plasticity.

The second stage of production now begins. Making of the actual pottery is by three principal systems—hand throwing, the traditional way, now confined mainly to the better quality of vases, bowls, jugs, etc.; jolleying; and casting.

In jolleying a quantity of clay body is put on to a rotating plaster mould, in the shape of the ware to be formed, and a steel or tungsten carbide form tool is pressed down to shape the opposite surface. In casting, a two or more piece plaster mould is made and a liquid clay mixture poured in. After some time the solids in suspension have deposited themselves on the plaster walls to the required extent, the surplus " slip " is poured off, and the plaster mould is removed.

All ware has to be dried out to a certain point before firing, to give it a degree of mechanical strength and remove surplus moisture which would otherwise contaminate the biscuit and glost kiln atmospheres. The ware driers have eight compartments only one of which is accessible for filling at one time. A complete rotation of the interior takes place every four hours. This preliminary drying absorbs a large amount of heat, at Wedgwood's obtained partly by live steam and partly by a low-pressure hot water system. Apart from the live steam service at 65 lb/sq in, there are three hot water circuits, for process drying at 200 deg F; for space heating; and for domestic use at 125 deg F.

The works has two back-pressure turbo-generators adjacent to the boiler house, used in winter on day shift

only, when there is a steam flow of up to 24,000 lb/hr, thus keeping the maximum demand on the public supply down. They feed a portion of the system separate from that fed by the public supply. The sets are by Brown-Boveri, with 12,000 r.p.m. turbines suitable for steam at 200 lb/sq in and 550 deg F, driving 1,500 r.p.m. generators, each rated at 450 kVA at 415 V, through reduction gearing. Air compressor plant is housed in the same building.

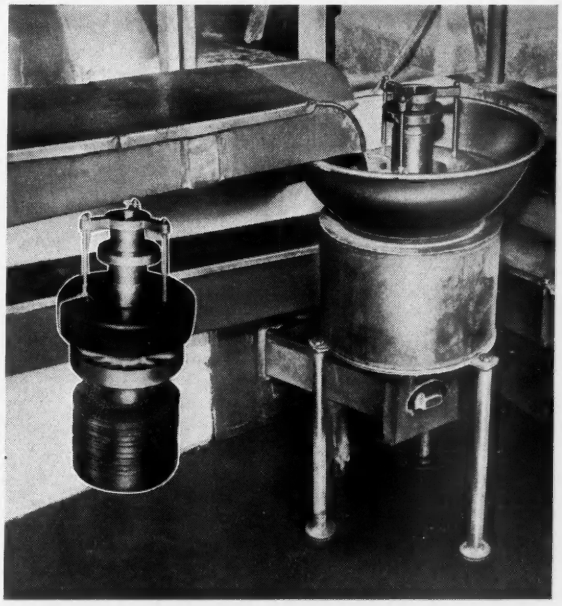
Supply for the works is obtained from the nearby Meaford generating station at 11 kV via a 0·2 sq in cable laid along the railway line, which goes past both works and power station. In addition a 0·06 sq in overhead line guards against total failure of supply in the event of a cable fault. Supply to the garden village is controlled from the works substation.

After jolleying many items are lathe turned to their exact shape and certain types of decoration can be formed during the turning processes. A wide variable speed range both forward and reverse is required for such work and among the systems used are the English Electric "Magamp" which makes for a fairly compact equipment running from an a.c. source: standard Ward-Leonard systems of drive are also used which are somewhat cheaper but occupy a little more total space.

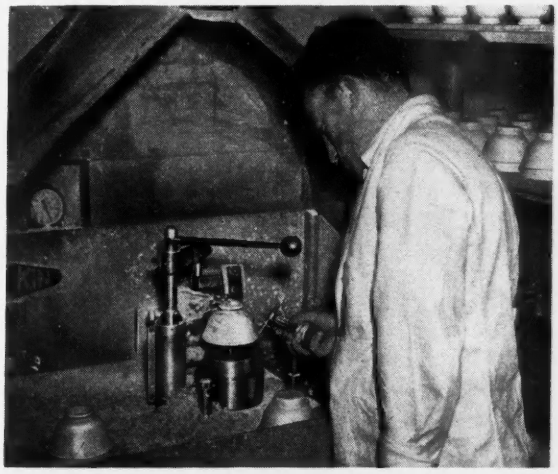
A semi-automatic turning machine used largely for cups can turn out about four cups a minute when fed by a quite unskilled operator. It uses tungsten carbide form tools as the wear is very great due to the abrasive qualities of the raw materials employed. A special vacuum chuck arrangement employs two distinct degrees of vacuum to hold the weak cup firmly against the heavy cutting force. A sliding sleeve within the cup, after accommodating itself to the individual contour is locked in position by the centrifugal force of internal lead weights as the chuck starts to revolve and at the same time an internal vacuum is applied to the cup to hold it firmly down on the rotating head.

Electric Firing Kilns

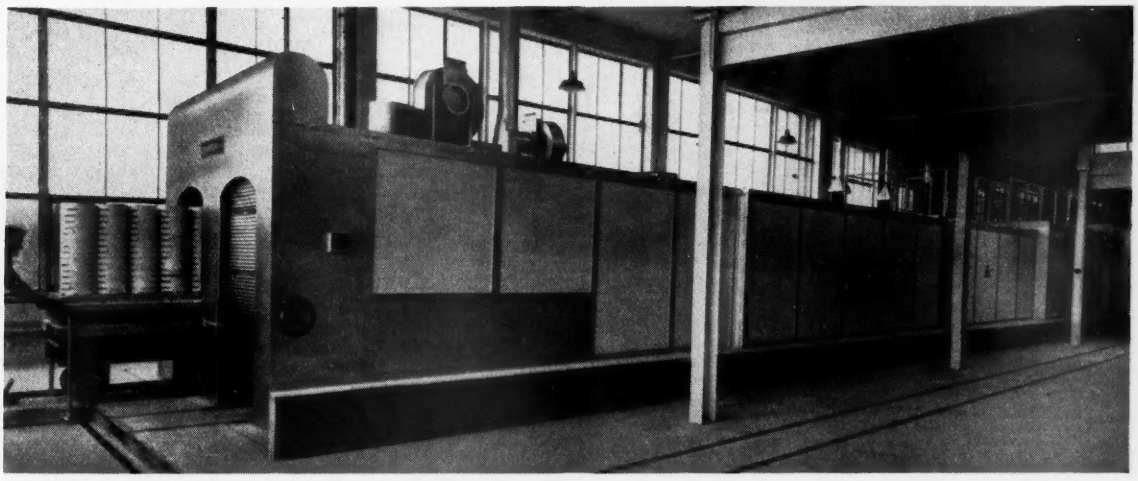
Correct firing of the formed ware is the key to good pottery manufacture and at Wedgwood's this is done entirely electrically. There are three long double kilns of Brown-Boveri manufacture, two being used for earthenware and the other for china. In addition, there are three smaller electrically-fired kilns for decorated ware. The twin earthenware kilns were installed a number of years ago and provide for biscuit in one tunnel and glost ware



Magnetic separator in use and (inset) iron core of separator showing edges. Below: Semi-automatic lathe



Below: Side view of one of the electric kilns



in the other, both processes requiring temperatures between 1,100 and 1,200 deg C.

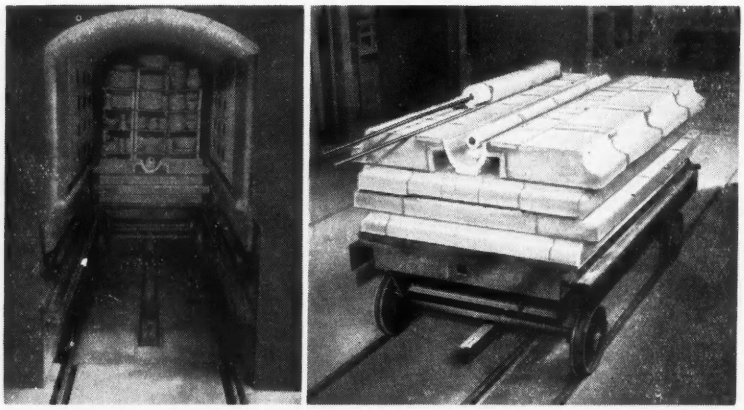
A continuous movement of trucks loaded with ware for firing takes place in opposite directions in each of the twin kilns, the time taken for a truck to travel the whole length being approximately 70 hours. The base of the truck itself forms the lower insulating barrier. To provide a fairly complete gas and heat seal, projections at the base of the fire brick portion of the truck run in troughs of sand, and a labyrinth arrangement of the fixed and moving bricks can be seen. All this is most important in pottery firing as there must be no uncontrolled movement of air within the kiln and no unpredicted temperature gradients. An even and planned variation of internal temperature is required over the total length.

The idea of having two kilns side by side is that a greater thermal efficiency can be achieved, the overall heat requirements being less because of the common central wall. Also, hot air from the cooling ware at the tunnel exits can be ducted to preheat incoming ware at the adjacent entrances.

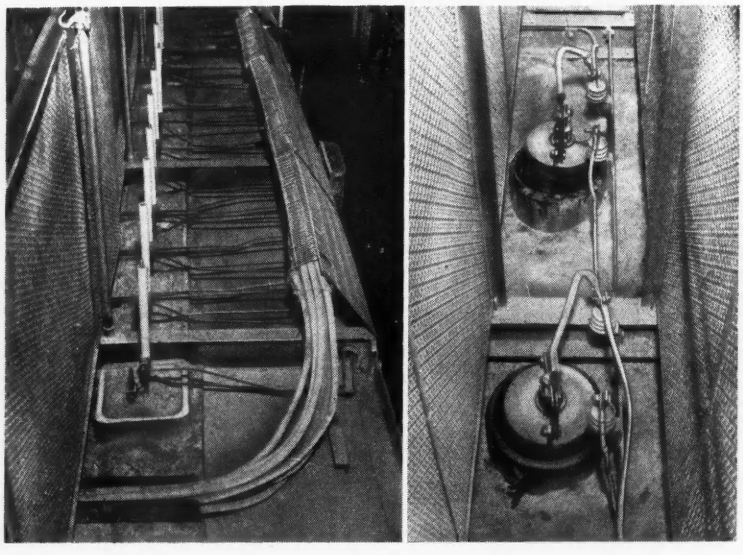
In this earthenware kiln which runs at a slightly lower temperature than the china kilns, the heating elements are all made of " Kanthal " aluminium-iron resistance material. This is wound on refractory formers and the main heating elements for the kiln are lowered through tubes from the roof. In addition, there is a subsidiary heating element on each truck to help in maintaining an even temperature and the supply to this is obtained via conductor rails, and electrical pick-ups on the chassis of the trucks.

Supply to the kilns is at 240/140 V, from three special transformers, of 750, 600, and 500 kVA rating, with earthed neutrals. Current transformers in the neutrals at the transformers are arranged to trip the h.v. oil circuit-breakers when the earth current reaches 20 A. The kilns are connected to their respective transformers on three wires only. Indicating pyrometers are mounted on panels, together with other instruments and a system of neon lamps is connected with all elements to give indication should any become open-circuited.

Movement of the trucks through the tunnel kilns is by a hydraulic ram with a stroke equal to the length of one truck. Oil pressure is obtained from a small electric pump unit underneath the tunnel and the ram slowly pushes the complete line of trucks forward by its pressure on the first truck. Specially reinforced steelwork under the truck transmits the thrust. When the ram gets to the end of its stroke it retracts automatically and there is then space at the entrance of the kiln for the entry of another loaded truck.



Left: A loaded truck inside the kiln and (right) kiln truck, with its own heating element in place and a tunnel wall type " Kanthal " element lying on top



Left: Top of " Kanthal " elements above the kiln and (right) of the " Globar " elements

Arrangement of Elements

Among the difficulties which have to be overcome in constructing kilns of this type is the fact that refractories are conductors at high temperatures and adjacent elements have to be arranged to give the minimum possible voltage gradient from element to refractory and back to the element. It is obviously better to have the lowest possible voltage on the kiln.

The most recent kiln installation is that of the twin tunnel kiln for china biscuit firing at an average maximum temperature of 1,248 deg C. This is 185ft in length and operates in counter-flow as does the one previously described. The temperature of operation of this kiln is higher than that used for earthenware and the duty on the heating elements is consequently more severe.

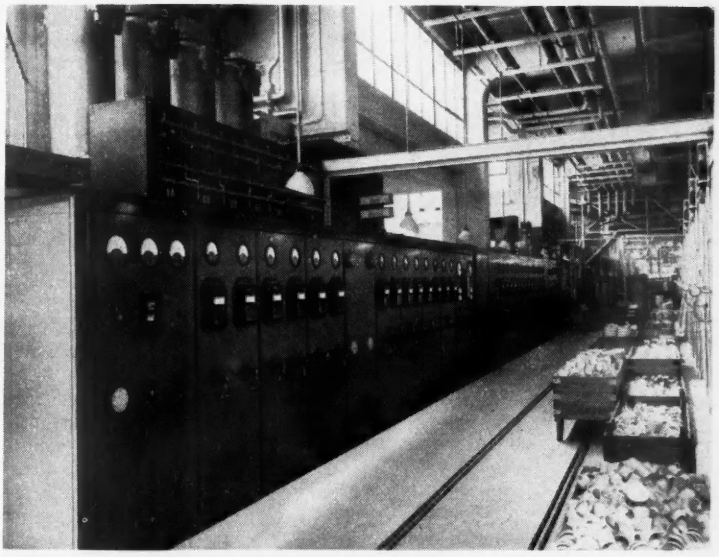
Fifty-four " Kanthal " elements are employed in the preheating and early firing zones and eighteen " Globar " elements made of silicon carbide by the Carborundum Co., in the hottest zones. Both types of elements are fixed vertically in the side walls of the kiln.

The " Globar " elements deteriorate with time owing to burning out of the graphite included to increase the electrical conductivity and also to the breakdown of the silicon carbide. Both the removal of admixed graphite and the formation, from the silicon carbide, of silica with its high electrical

resistance, increase the resistance of the elements, and consequently the heating effect for a given voltage decreases. Thus the progress of the decay can be followed and each element has a separate ammeter on the control panel.

The resistance of the silicon carbide elements varies considerably as they heat up and they are split up into three groups of six rods each, in each tunnel. Each group is supplied through a 50 kVA three-phase induction regulator controlled by a Brown-Boveri type Q2 control relay (Ferraris principle) tending to maintain a constant power to each group. The balance of the relay can be upset by a series resistance cut in or out by the pyrometer of the group. The maximum load of these twin tunnels is about 450 kW, which results in the firing process having a consumption of approximately 4,000 kWh per ton of ware produced.

In order to prevent gas leakage past the "Globar" elements an inverted cup is fitted to the top of the element, the rim of which rides in an annular container of oil. The element itself is in three parts, contact between the three being by contact pressure only, a convex form on one part fitting into a concave form on the next. The inverted cup used for gas sealing is heavy and serves also to maintain sufficient contact pressure.



Kiln control panel

Mechanical aids in the decoration of china and earthenware are few. Electrically-heated engraved copper cylinders are used for the printing of paper transfers and an interesting machine is that used for printing designs on ware. A pneumatically operated plunger head formed of gelatine in a suitable shape for the ware being printed first presses on to a metal engraving of the pattern coated with ceramic colour, then comes down on to the ware, which has been placed in a resilient gelatine base.

Although this factory produces china and other ware among the finest in the world, a steadily growing demand means that modern quantity production techniques have to be constantly wedded to craft knowledge, and in the achieving of this difficult blend, Wedgwood's are well to the fore. It is worth noting too that more than half of the company's total output is exported to the North American market.

Scientific and Engineering Manpower

A REPORT on the number and distribution of qualified scientists and engineers in employment now and in the future has been issued jointly by the Ministry of Labour and National Service and the Advisory Council on Scientific Policy (H.M. Stationery Office, 1s 6d). The document embodies the results of two related inquiries concerning respectively the position three years hence and the likely long-term demand.

The term "qualified" is taken to refer to those possessing a university degree, to corporate or graduate members of specified professional institutions and to associates of certain educational institutions. At present the total number of qualified persons, 134,700 (representing 0·6 per cent of the whole working population of 24 million), is made up of 56,230 scientists and 78,470 engineers, exclusive of 4,700 scientists and 2,300 engineers engaged in post-graduate research or on National Service. In addition there are 30,150 engineers (mostly in industry) holding only Higher National Certificates or Diplomas or their equivalents.

The 134,700 are distributed in the following percentages: manufacturing industries, 43½; nationalised industries, 12½; teaching, 21; central Government, 10; local government, 5; miscellaneous, 8. About half of the qualified scientists are engaged in teaching and three-quarters of the qualified engineers are in industry.

Nearly two-thirds of the 48,800 engaged in manufacture are in industry groups that account for only three-tenths of the total employed but include two-thirds of the scientists and engineers, 45 per cent of whom are occupied in research and development. Electrical engineering has much the highest figure with 12,200, which forms 2 per cent of the total number employed compared with an average for all industries of 0·8. The Atomic Energy Authority with 10·9 per cent comes easily first, followed by mineral oil refining with 5·2 and electricity authorities with 2·9 per cent compared with 1·2 per cent of the Gas Council and Area Boards.

Industrial requirements in 1959 are estimated by employers at 33 per cent above the present figure of 71,100 to reach 94,650, including an allowance to meet the existing shortage. Teaching will need to increase from 28,050 to 31,050 which will be included in a non-industrial addition of 6,800 or 14 per cent. Of an overall total increase in 1959 of 30,300 (26 per cent), which would bring the total number of scientists and engineers to 150,000, electrical engineers are expected to account for 5,100 (29 per cent increase), making their total 22,900.

The long-term demand is based upon evidence of equivalence between the rate of increase of industrial production as a whole and the number of trained scientists and engineers employed. Assuming an increase in production at the rate of 4 per cent per annum, the number of scientists and engineers in industry during the next decade should be raised from 135,000 to 220,000, to give an increase of 70 per cent in engineers and 50 per cent in scientists. This would entail an annual supply of entrants from universities and technical colleges of 16,000 by 1966 and 20,000 by 1970 instead of the present 10,000. National policy should be designed to encourage raising the present proportion of those eligible who remain at school until the pre-university year from 9 per cent to 15 per cent.

Indian Steelworks Contract

Particulars of Electrical Equipment

UNDER the terms of the final contract signed in Delhi on 31st October the Indian Steelworks Construction Co., Ltd.—a consortium of thirteen British companies—is to equip and construct for the Government of India a complete iron and steel works at Durgapur, West Bengal. The member companies of the consortium, known as "ISCON," are the Davy and United Engineering Co., Ltd., Head, Wrightson & Co., Ltd., Simon-Carves, Ltd., the Wellman Smith Owen Engineering Corporation, Ltd., the British Thomson-Houston Co., Ltd., the English Electric Co., Ltd., the General Electric Co., Ltd., the Metropolitan-Vickers Electrical Export Co., Ltd., Sir William Arrol & Co., Ltd., the Cleveland Bridge & Engineering Co., Ltd., Dorman Long (Bridge & Engineering), Ltd., Joseph Parks & Son, Ltd., and the Cementation Co., Ltd.

The value of the plant, equipment and materials from the United Kingdom will be over £50 million, and a considerable amount of work will be available to sub-contractors and suppliers of ancillary equipment and materials both in this country and in India.

The iron and steel producing sections of the Durgapur works will have a rated capacity of 1,250,000 tons of ingots per year and 360,000 tons of pig iron. The provisional programmed output of the rolling mill and railway wheel, tyre and axle plant is 790,000 tons, based on an ingot production of a million tons per year, and will be made up of forging blooms and billets (100,000 tons), billets for re-rolling (150,000 tons), merchant bar and sections (440,000 tons), sleepers (60,000 tons) and railway wheels, tyres and axles (40,000 tons). The addition of soaking pits and finishing mill capacity to the plant to be supplied will permit of the whole of the ingot capacity being used.

The construction programme provides for the completion of the entire works by August, 1961, but the first and second blast furnaces with adequate coke making capacity and ancillary services will be in operation by November, 1959, and May, 1960, respectively. The consultants for this and other steelworks projects of the Government of India are the International Construction Co., Ltd., London.

The engineering of the principal sections of the works, i.e. the coke oven, blast furnace, steel making and rolling mill sections, has been the responsibility of the four mechanical engineering companies of the consortium and the technical co-ordination of these sections and the engineering of ancillary services has been carried out by the Metallurgical Equipment Export Co., Ltd. The consultants for the electrical work were Messrs. McLellan & Partners.

The four electrical companies will be supplying a wide variety of plant including power station equipment, some 2,500 motors ranging in size from 1 h.p. to 7,000 h.p. (the latter being for the main drives for the rolling mills) and the complete distribution system for the steelworks including nearly 100 transformers, rectifiers, a considerable quantity of switchgear and fusegear of various types for voltages up to 30 kV, lighting, telecommunications, cables and ancillary equipment.

The main power house will be the responsibility of Simon-Carves, Ltd., and Metropolitan-Vickers. To be installed are four 150,000 lb/hr gas-fired boilers, of which two will be equipped for alternative solid fuel firing, three 5,000 kW turbo-alternators and four large G.E.C. turbo-blowers.

The equipment to be built by the British Thomson-Houston Co. will comprise the main drive for the 42in blooming mill, turbo-exhausters for the coke oven plant, diesel-electric locomotives, some of the electric motors for auxiliary drives, switch and control gear and approximately half the lighting installation and telecommunication equipment for the complete works.

The English Electric Co. will supply the main mill drives for the 32in intermediate mill and the continuous billet mill, switchgear, transformers and rectifiers, industrial and mill type motors, control gear and auxiliary motor generator sets, as well as mechanical parts for the diesel-electric locomotives.

The General Electric Co. is to provide the main mill drives for the Morgan continuous merchant mill, four turbo-blowers for the blast furnace plant, industrial and mill type motors, control gear and approximately half the lighting installation and telecommunication equipment for the complete works.

The Metropolitan-Vickers Electrical Export Co., in addition to the three turbo-generator sets, will supply the main and auxiliary electrical equipment for the 24in medium structural mill and wheel and tyre mill, condensers for the turbo-blowers, together with a large number of the auxiliary motors, 3·3 kV distribution switchgear and transformers for supplies below 11 kV.

The supply and installation of all cables and ancillary equipment including steelwork, cleats, racks, cable trays and cable jointing throughout the steelworks will be undertaken by a cable group formed between the Edison Swan Electric Co., Ltd., Pirelli-General Cable Works, Ltd., and Siemens Brothers & Co., Ltd., and electric furnaces for the foundry will be of the Electric Furnace Co.'s manufacture.

Thinking Machines

THE 1956 Viscount Nuffield Paper was presented before the Institution of Production Engineers on 17th October by Dr. W. Grey Walter (Burden Neurological Institute) at Bristol University. It discussed tentative results of recent research into the functioning of the human brain and nervous communicating system in relation to thought in its more complex manifestations and to the performance of computing machines. If the word "thought" was confined to logical step-by-step "yes or no" processes, modern binary computing machines could often do the work better, but thought depended also on a sort of statistical reflection and a comparable computer would have to include some analogue device having the functions of a totalisator casting the odds in terms of "perhaps" and "think again."

Electrical changes went on incessantly in all living brains, but paradoxically the greater the mental activity the less prominent were the electrical discharges from something like 10,000 million cells, all capable of continuous interaction.

Mankind was moving rapidly from an age of experimental technology to one of automation. Almost as important as inventiveness and enterprise were human indolence and fatigue. Although operations in arithmetic and formal logic could be more readily mechanised than others, the amplification of reasoning powers by artificial thinking machines seemed a possibility.

COMMERCIAL DEVELOPMENT OF THE "FRIDGE-HEATER"

Domestic Heat Pumps

By B. Z. de FERRANTI, B.A., Grad.I.E.E.*

THE principle of the heat pump has been widely known for a considerable number of years, but until the last two or three years no serious attempts have been made to produce a commercial model. It is true that several pioneers had experimented with various prototypes but these, in all cases, were specialised applications which did not easily lend themselves to economical production. However, in the last few years the heat pump system has become more attractive, mainly for two reasons.

Firstly, the designs of compressors, particularly the small horse power internally sprung hermetic unit, have improved to the point where a ratio of output to input of 2·8 to 1 can be maintained. Secondly, the dwindling national coal resources and the increased costs of mining this coal have caused prices to increase to the point where the heat pump can offer heat at a cost less than that of solid fuel. This means that the comparatively high cost of a heat pump installation will, over a period of time, be offset by reduced running costs. This is only true if use is being made of both functions of the heat pump, i.e. heating and cooling.

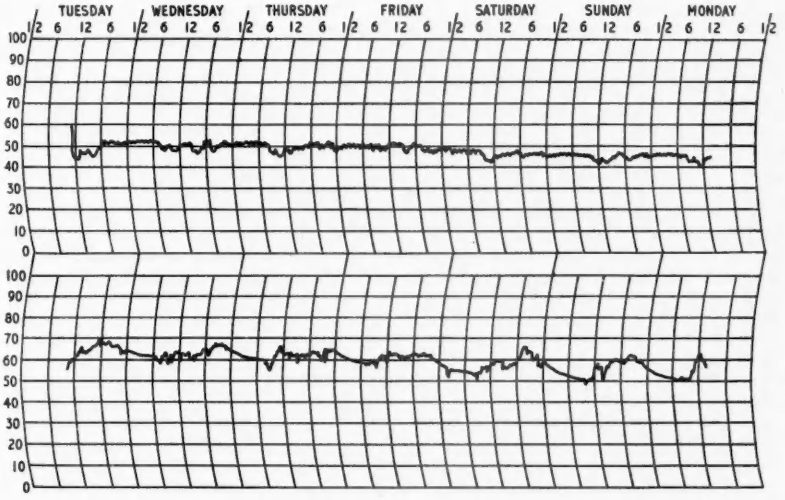


Fig. 1.—Larder (a) and kitchen (b) temperatures in a January week

There are many industrial applications which no doubt will be the subject of future developments, but this article concerns itself with the development of a domestic version of the heat pump system. There are two possible domestic types which satisfy the condition of using both functions of the heat pump and these are all-the-year-round air conditioning of the home and the combined function of larder cooling and water heating.

It is questionable whether the English climate will enable economical installations of the first type of heat pump to be made, and this question is still to be resolved. However, early development work by Mr. G. O. McLean of the South Western Electricity Board and by Miss Griffiths of the Electrical Research Association showed the second type of installation to have definite commercial possibilities. The method used was to immerse a hermetically sealed motor compressor and condensing coil in a 30 gallon storage tank in the airing cupboard and then to run refrigerant pipes down to the evaporator in the larder. Performance ratio, larder and water temperatures were satisfactory, but the design was not practical because waterproofing of the motor compressor and terminals was too expensive; differing lengths of pipe between the evaporator and the condensing unit made the evaporating conditions uncertain; the unit would have to be charged with refrigerant on site; it was difficult to overcome condensation on the refrigerant pipes; and the unit was very noisy.

It was in the light of information gained from these experiments that development work was commenced by Ferranti, Ltd., on a water-heating/larder-cooling heat pump. A considerable amount of the early experimental work was spent on an investigation into heat exchanger characteristics and the compressor performance, as well as the feasibility of using capillary tube as the expansion device. A prototype packaged unit was built up comprising a Sterne universal ¼ h.p. motor compressor with the condenser mounted above it enclosed in an insulated cabinet. The evaporator unit, ice maker and fan were mounted on the top of the cabinet. The heated water from the condenser was circulated by thermo-convection to a storage tank.

This design overcame all but the final difficulty mentioned above. It had two especially interesting features. Firstly, the heat loss from the storage tank, which could be usefully

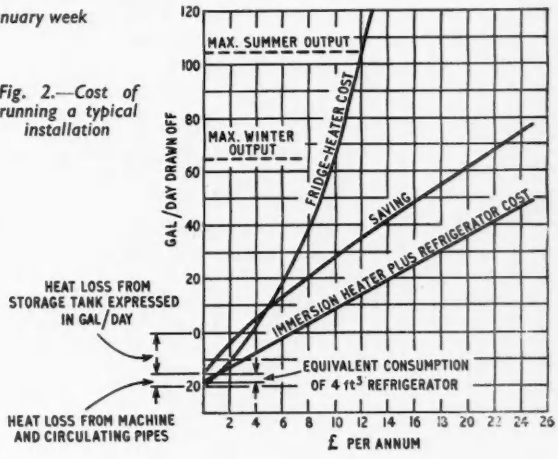

MAX. SUMMER OUTPUT
MAX. WINTER OUTPUT
FRIDGE-HEATER COST
SAVING
IMMERSION HEATER PLUS REFRIGERATOR COST
GAL/DAY DRAWN OFF
HEAT LOSS FROM STORAGE TANK EXPRESSED IN GAL/DAY
EQUIVALENT CONSUMPTION OF 4 ft³ REFRIGERATOR
HEAT LOSS FROM MACHINE AND CIRCULATING PIPES
£ PER ANNUM

Fig. 2.—Cost of running a typical installation

* Manager, Domestic Appliance Department, Ferranti, Ltd.

employed in warming an airing cupboard, was sufficient to keep the machine running for a long enough period to maintain a cool larder when no hot water was being drawn off. This was obviously preferable to having the storage tank integral with the unit since such an arrangement involves installing a heat leak outside the larder which keeps the unit running continuously, with consequent increase in capital and running cost. Secondly, the fan maintained the evaporation temperature as high as possible, giving a maximum performance ratio, and if it was desired to make ice it was only necessary to switch the fan off. The prototype performed satisfactorily in the laboratory and several more were made up and installed in the houses of employees of the firm.

It was found that during the winter the evaporating temperatures were rather low and the output consequently poor. This was improved by increasing the evaporator capacity. Food storage during the hot summer months proved excellent. The larder air was not only cooled but cleaned, reduced in humidity and kept circulating as well. The ice making feature was also much appreciated. Fig. 1 shows a thermograph recording of larder temperature and adjacent kitchen temperature, and Fig. 2 shows a curve deduced from the test results, comparing the running cost with a conventional refrigerator and immersion heater. It was found necessary also to bring the cold feed from the head tank directly to the condenser. This ensured that the machine, should it happen to be on an "off" cycle, would come in immediately there was a draw-off and the vapour would be condensing into cold water for as long as possible.

A production model was then designed incorporating the Sterne ¼ h.p. motor compressor internally sprung within the dome and mounted on top of the condenser. It was shown that the oil in the bottom of the dome could be kept cooler in this way and winding temperatures maintained well below the danger point. The new compressor virtually solved the noise problem as well.

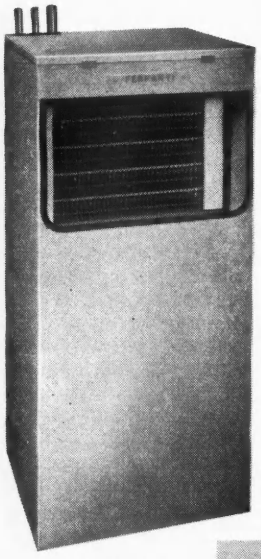


Fig. 3.—The Mark I "Fridge-Heater" incorporating a ¼ h.p. motor compressor

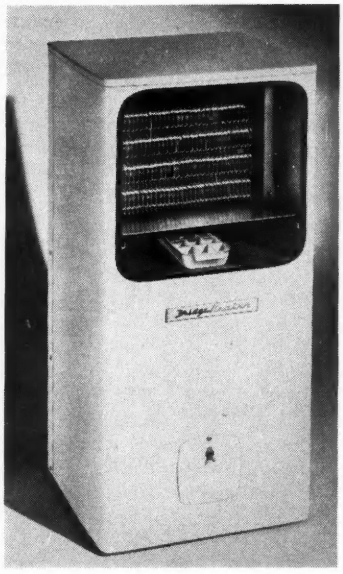


Fig. 4.—Continued research led to such refinements as the central grouping of electrical controls and re-positioning of the ice-making compartment incorporated in the Mark II model

This more or less completed the development of the heat pump unit for water-heating/larder-cooling and a model Mark I, Fig. 3, was produced and distributed in limited quantity, proving that the domestic heat pump was a practical possibility. The problems which remained at this stage were largely those concerned with practical development of the machine and with its associated production problems.

Continued research led to refinements being introduced, i.e. the central grouping of electrical controls making far easier servicing, the re-positioning of the ice-making compartment for speedier ice making, the reduction in the number of pipework connections to be made and re-tooling to facilitate the production of the unit.

This new unit became known as the Mark II version of the "Fridge-Heater" and is illustrated in Fig. 4. This unit is now in quantity production.

The problems which remain are more commercial than technical and there is still a very great deal to be done in training distributors and increasing the already lively interest among builders, architects and the general public.

E.R.A. Reports

AMONG the research reports which have recently been issued by the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, is Ref. L/T321, "The Effects of Small Discharges on Some Insulating Materials. I," by N. Parkman (price 12s 6d) describing investigations into the rate and mode of deterioration of some plastics when subject to small discharges in cavities enclosed in the material. A new electrode assembly was developed to enable the tests to be carried out in air. The effects produced by the discharges vary with the mechanical as well as the chemical properties of the material. Future work is outlined.

Hydrogen Investigations

In Ref. L/T350, "A Study of Ionisation Coefficients and Electrical Breakdown in Hydrogen," by A. Wilkes, W. Hopwood and N. J. Peacock (price 12s 6d), work is described in which experimental measurements of the Townsend ionisation coefficient α for hydrogen have been made from a study of pre-breakdown currents in uniform dielectric fields over a range of the parameter E/p from 15 to 40 V/cm/mm Hg. The results indicate that earlier measurements may be in error below E/p=25 V/cm/mm Hg, and show good agreement with the theoretical calculations of Emeleus, Lunt and Meek (1936) which are based on a Maxwellian distribution of electron energies. Furthermore, measurements made at different gas pressures for the same value of the parameter E/p show that α/p is a function of E/p. The results are discussed in the light of existing theories of electrical breakdown, and it is concluded that the Townsend mechanism is sufficient to explain the initiation of breakdown in hydrogen up to a pd value of at least 2,800 cm/mm Hg.

Grain Moisture Measurement

Ref. W/T30, "The Measurement of Surface Friction of Grain to Determine its Moisture Content," by P. Finn-Kelcey, A.M.I.E.E., A.M.I.B.A.E., and P. E. Clayton (price 15s), describes the development and design of an instrument for measuring the moisture content of whole grain. The meter operates on the principle that the surface friction of grain varies with the moisture content, and by measuring the depth of penetration of a weighted blade into a mass of grain, the moisture content can be obtained.

I.E.E. NORTH EASTERN CENTRE
CHAIRMAN'S ADDRESS

In his address Mr. Christie dealt with the manufacture of switchgear under four broad headings—production, materials, measurements and testing, and office facilities—and gave numerous examples of how progress is being rapidly advanced.

Switchgear Manufacture

A WEALTH of information on what he termed the everyday efforts of the research, design and production engineer engaged in the manufacture of switchgear, was given by Mr. J. Christie, M.I.Mech.E., in his chairman's address to the North Eastern Centre of the Institution of Electrical Engineers.

Dealing with production, he said that shell moulding in the foundry was an example of the way in which operations had been mechanised and new methods adopted. The process involved making thin shell moulds using a mixture of selected sand and resin which, after baking, was porous and therefore allowed the hot gases to escape during casting. The accurate dimensions and fine finish possible with this method enabled substantial savings to be made both in material and machining costs.

In the welding field the deep penetration obtainable by the automatic submerged arc process minimised the number of welding runs, while the freedom from spatter eliminated the expense of weld cleaning and the absence of arc glare contributed greatly to good working conditions.

By means of a special welding gun, studs or pins with treated ends could be welded directly into position even on comparatively thin plates without the risk of subsequent oil leakage, and this was another way in which welding was saving time and material.

Surface treatment of materials was an important manufacturing process which found applications ranging from the initial cleaning of a material to the production of the final finish. A portable sand blasting plant was now available in which the shot was confined to the immediate area of surface being treated and was then automatically returned to the machine for re-use.

In the final treatment of contact surfaces, it was now usual practice to silver-plate such surfaces to avoid oxidisation and consequent trouble due to overheating, and portable equipment was available by which a layer of silver could be electro-chemically deposited in about 10 minutes.

Control boards called for a large variety of holes and slots in sheet steel panels, and the production of these could now be carried out on a single heavy duty turret press which operated with the speed of the punch press, allowed the sheet steel to be quickly positioned, and had the necessary punches and dies immediately available.

New Insulating Materials

Under the heading "Materials" the author said that epoxy resins were now available which, with suitable fillers, were impervious to moisture, mechanically robust, had good non-tracking properties, and did not support combustion. These resins were finding an increasing application in replacing many of the types of insulating materials at present used in medium-voltage metalclad switchgear, while their mechanical properties were opening up the possibility of a new approach to the design of this equipment.

Among many interesting proving tests, current transformers were subjected to faults equivalent to 250 MVA, 11 kV, i.e. 13,100 A, maintained for one-third second to establish how much damage was caused when a puncture or flashover took place. These tests showed that the surface flashovers produced negligible damage, and in fact after the equipment was cleaned and re-tested it was found to be completely serviceable.

To simulate an internal puncture, a transformer with an artificial fault between the primary and secondary was tested, and it was found that although a small portion of the moulding broke away no fire resulted. It was also known that present types of voltage-transformer fuses were not very effective in protecting against a between-turns fault on the high-voltage windings and in consequence a slow growing fault of this type could cause overheating and might, with oil filling, cause a fire. A resin-insulated design, on the other hand, avoided the need for oil and, he considered, strengthened the case for omitting the potential fuse which for years had been the aim of many engineers.

Of the many gases studied for use as an insulating and arc-quenching medium in circuit-breakers, sulphur-hexafluoride seemed to be the most promising. It was about five times as dense and three times as effective as air when used as a cooling medium, and had a dielectric strength of about one-and-a-half times that of oil when used with the clearances normally met with in switchgear.

Vacuum Technique

The use of a vacuum tube for limited circuit-breaking duties was another interesting development. It had not been possible previously to take advantage of the extremely high dielectric strength of a gap in a vacuum for circuit-breaking purposes because the gases produced by the contacts during arcing destroyed the vacuum. But it was now possible to de-gasify tungsten arcing tips, and with the improved vacuums now obtainable this difficulty was overcome. In a practical design tungsten butt contacts were enclosed in an evacuated glass envelope and operated through a metal bellows, the contact travel being of the order of $\frac{5}{32}$ in. On electrical pressure test it had been found that flashover took place externally over a distance of about 8in rather than across this small contact gap. Designs of this type were already in service in the U.S.A. for interrupting line-charging currents and banks of capacitors.

Transistors made of germanium were now available, and because of their small size, robustness, long life and simplicity, it was considered that they would replace, with advantage, thermionic valves in such applications as carrier protective systems.

Dealing with measurements and testing, Mr. Christie said that in the quality control field steel plates could be checked for layering by means of a device which applied a repeated mechanical impulse to the surface of the material. In a normal plate these impulses were reflected from the reverse side, whereas in a faulty plate reflection occurred from the fault and this could be detected by examining the frequency of reflection on a cathode-ray screen. The

highly penetrating nature of gamma rays was enabling important welds on air receivers and the like to be photographically examined, while normal X-ray examination remained invaluable for checking the assembly of cartridge fuses or the insertion of foil layers in condenser insulators.

The electrical design of bushings and insulators could be quickly and accurately checked by immersing a model in an electrolytic tank and plotting the actual stress field by means of probes. The thickness of non-magnetic coatings, such as paint, on magnetic materials could be measured by means of a device which consisted of a permanent magnet and a flux measuring instrument. After the zero had been adjusted on the surface of the virgin metal the meter was placed on the coating to be checked and the thickness read directly from the scale. A moisture meter was now available to avoid the troubles which could arise due to electrical equipment being packed in damp material. This consisted of a bridge arrangement with two probes to which was applied a d.c. potential and the percentage of moisture could be read directly on the meter scale.

In the research field the suitability of "Perspex" for constructing experimental arc-control devices and tanks, and the recent development of photographic techniques which made it possible to take up to 400,000 pictures per second, were enabling arc phenomena to be studied in detail, particularly during the critical zero pause period.

Finally, for proving complete circuit-breaker designs larger testing stations were being built, higher voltages were becoming necessary in the laboratories, and many other facilities, such as icing chambers, were requisite to simulate actual climatic conditions.

ELECTRICAL SCIENCE AND INDUSTRY

PROFESSOR G. H. Rawcliffe started his inaugural address as chairman of the Western Centre of the Institution of Electrical Engineers by pointing out that professional engineering was a curiously blended mixture of science, technology and administration. To electrical engineering science was fundamental, but the biggest single element in all professional engineering was administration followed closely by detailed constructional design. The electrical industry rested on the discoveries of a few creative geniuses and more immediately upon the labours of a comparatively few well-trained applied scientists.

University teachers were the ultimate source of creative thought in electrical science. They were not mere purveyors of information, but performed a considerable amount of original work and inspired their students to do the same. In fact, the university existed primarily to foster the creative scholar, the original experimentalist and others of that type, in order that its fundamental task of maintaining the nation's intellectual currency might not be forgotten in the hurly-burly of giving routine instruction to large numbers of intellectually pedestrian students.

There was no pleasure equal to that of working out from theory the behaviour of some new or much modified apparatus, supervising its manufacture and then observing its performance on test as a confirmation of the theory. It might be objected that to sacrifice wealth and position in order to enjoy these creative satisfactions was unrealistic. To a great extent this was true when applied to most people, for the electrical industry and profession offered inadequate rewards and insufficient status to engineering ability as such. The great importance of administrative and managerial skills had to be recognised, but a relative increase in the rewards and status of those who preferred to stick to straight engineering was necessary if shortages in the 40 to 55 age range were not to continue. In fact, the profession would have to adjust its scale of values if we were to continue to make technological progress.

Physics and Electrical Engineering

Examining the relation between physics and electrical engineering and the arguments for studying either as the entry to a career, Professor Rawcliffe said that many physicists under-rated the gap between a simple scientific principle and its useful employment in a piece of engineering equipment. Only after a little reasoning in the hard school of experience did many a physicist learn that after passing on from the primitive scientific concept there was still a large body of complicated theory which had to be mastered before the constructional side could be considered.

The whole tone of the physics departments of the country's universities tended to be geared to the very latest modern discoveries. From the point of view of the national well-being, however, the situation was unhappy because it was out of scale with the facts. Although pure scientists were always ready to acknowledge the contribution of the constructional engineers who finally carried the plans of applied scientists into action, they were much more reluctant to give credit to those applied scientists who must develop the primitive scientific concept into a full technological subject before constructional engineers could even begin.

Very few people in any generation had the talent or temperament to perform original research in pure science. Even of those of a potentially high creative calibre only some could properly be engaged in physics and a great many ought to turn to applied science, including electrical engineering. A boy should be prevented from taking a first degree in physics unless he was of the first-class honours type and was of the temperament likely to continue with laboratory work. Further, a great number of first-class people should be compelled to study engineering science and the amount of physics taught to electrical engineers should be increased.

Undergraduate Studies and Research

The electrical engineering departments of the universities had tended until recently to concentrate too much on their didactic function and to think too little of their duties as places of creative learning and research. The reverse was true of the physics departments, which acted as though the latest line of research was all that mattered.

The increased capacity for effective action of a research graduate, compared with a first degree student immediately after graduation, had to be experienced to be believed. There was something to be said for the future research and development engineer going into industry immediately after graduation. On the other hand, once such a man had had two or three years in industry a further period of scientific study at a university before finally settling into a productive career would be ideal. A considerable number of men who had been in industry for some time before taking their full university course were also ripe for post-graduate study after they had taken their first degree. These men might take a little longer to mature than some others, but they would provide some of the leaders upon whom the manufacturing industry depended.

VIEWS on the NEWS

By REFLECTOR

MR. B. J. PRIGMORE, M.A., M.Sc., A.M.I.E.E. (of Imperial College, London, S.W.7), who is known to my readers as the author of articles which have appeared in the *Electrical Review*, has sent me a copy of a little cyclostyled journal produced by the Electric Railway Society. He tells me that the Society is the only one which caters especially for those interested in electric railways and assures me that it is not a group of young "spotters"; in fact it "discourages this approach to railway studies." The members include professionals and the meetings are "intellectually satisfying as well as being interesting and informative." It is gratifying to know that now steam locomotives are on the way out the societies which fostered interest in them are followed up by such a group of electric traction enthusiasts. Among the subjects dealt with in the journal are "The Last of the Oerlikons," an appreciation of the service given by this and its sister trains in the London area; "Contrasts in Train Heating and Lighting Practice"; the Liverpool Overhead Railway (which, alas! is closing down at the end of the year); and a variety of news items.

* * *

The Thurmaston (Leicestershire) Parish Council has decided that the village has too much light and so some of the lamps are to be put out of use to save money. A member of the Council said that one area of the village was known as "Blackpool illuminations." Thurmaston must be unique among English villages in its enlightenment.

* * *

The North of Scotland Hydro-Electric Board, in spite of its great endeavours to avoid doing harm to salmon fishing in its area, is still being subjected to the strictures of local bodies. The Scottish Landowners' Association has been attacking again both on the ground that salmon fishing is being injured by the Board's activities and because it is said to be undertaking uneconomic schemes. In commenting on the subject the *Bulletin and Scots Pictorial* says that electric cookers, heating, lighting and television are doing much to make country folk content with their lot and if in some places these things are being supplied at less than the economic rate, "a suggestion which would probably astonish most recipients of hydro-electric accounts," then any reasonable amount of subsidy is more than justified.

> "It hardly seems necessary to go into comparisons between the value of salmon fishing and agriculture, but it can never be said often enough or strongly enough that anything in the least likely to check the depopulation of the countryside is well worth paying for."

* * *

Neckties are devised nowadays not only for alumni of public (and other) schools, regiments and clubs but for a variety of other bodies or movements. I have not yet heard of a special design for water-power enthusiasts but in the course of an argument about the Bann hydro-electric project in the *Belfast News-Letter* a correspondent signing himself "Cusecs" expresses the hope that the Bann Landowners' Association (who are not keen on the scheme) will provide a member to "crack" the valve at the opening ceremony, "where I shall be easily identified by my tie-pin which bears a miniature Pelton wheel."

* * *

To the uses of electricity on the farm one more can be added. The latest number of *Southern Electricity*, the magazine of the Southern Electricity Board, reports that an urgent call was recently received by the Newbury District office from a local farmer whose electric motor had failed. When the motor had been dismantled the remains of some thirty-four mice were found—proof of which is given in a photograph reproduced. Flies also suffer from this fatal attraction it would seem, for another note records that a cooker "Simmerstat" that had seized up was found to contain some thirty or more dead insects.

* * *

A report in the *Yorkshire Evening Post* says that "someone's going to have a pylon at the bottom of his garden." Apparently the Morley Council acquired land for a housing estate some time ago but before the houses could be erected a transmission line tower was put up by the Central Electricity Authority (no doubt with permission). Now, because the land has to be used economically the houses are being put up near the pylon and the tenants, as the report says,

> "will have to get used to the sizzling sound of the electricity which, a workman said, sounds 'like a giant frying pan full of bacon and eggs' on wet days."

* * *

The following note appeared in the *Electrical Review* of 12th November, 1886:—

> "*Lighting the 'Liberty' Statue.*—The Bartholdi statue, at New York, was illuminated by the electric light for the first time on the night of Monday week, being the first pleasant evening since the unveiling. The torch was lighted by nine arc lights arranged in two horizontal circles, one inside the other. There are five 8,000 candle-power electric lights in five of the salient angles of the fortifications surrounding the statue. Behind each light is a reflector, by which the light is focused on the pedestal and statue. Each light is four times as powerful as an ordinary arc light. The lighting was witnessed by enormous assemblages of people at the Battery, and along the wharves. The water was alive with craft of all kinds. When the signal for lighting was given fireworks in bewildering profusion blazed from the forts, islands, wharves, and vessels, followed almost immediately by a flashing white light from the torch, which sent dazzling rays over the waters of the harbour and far out to sea. The effect was marvellously beautiful."

Unfortunately to this report there was a footnote which said:—

> "The statue of 'Liberty' has remained unlighted since Saturday last for want of funds, Congress having voted none for the purpose."

All-Electric Heating in Woking Houses

Domestic Heat Pump Installations

A HOUSING estate which will comply with the provisions of the Clean Air Bill is being developed at the Orchard Drive Extension, Horsell, Woking. The houses, which will be electrically heated and without chimneys, are being built by J. S. Holmes & Sons, Ltd. The adoption of electricity for all services followed consultations between the Woking District commercial staff of the South Eastern Electricity Board and Mr. H. J. Holmes.

There will be forty-two houses of the six-room type, with garage, on the estate, and recently we had the opportunity of inspecting the first of these houses to be completed.

Outstanding features of the houses are that they will be insulated against heat loss, and each will have a Ferranti heat pump installed. In the house we inspected "Fibreglass" insulation has been placed over all the ceilings and the sealed cavity outer walls have been constructed with "Lignacite" insulating bricks. The Ferranti "Fridge-Heater" installed in the larder will give larder conditions of 42 deg F and will provide storage space of 120 cu ft instead of the much smaller accommodation of a refrigerator, although, of course, where it is required to maintain frozen foods and where "cold cookery" is required an additional refrigerator will be necessary. The "Fridge-Heater" will also produce all the domestic hot water requirements at a temperature of 140 deg F.

Saving in Building Costs

Heating in the rooms is by built-in "Thermovent" convector heaters, with the addition of a Ferranti reflector fire in the lounge and a "Saferod" fire in the kitchen, which also has a Jackson electric cooker. A Dimplex 0·75 kW radiator is installed in the bathroom. The cost of incorporating this installation in the house is £322, which represents a saving of £116 on the conventional fuel installation with its extra building costs. In addition to this saving there is a floor area gain of 25 sq ft without increasing outside dimensions, and thus without any increase in the general and water rates.

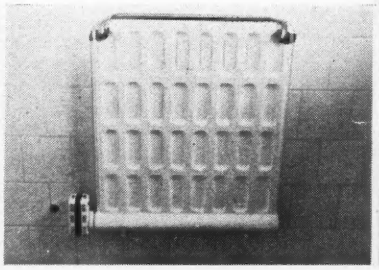
Some guide to the running costs of these houses can be obtained from figures relating to a house near the estate which the owner has had converted to all-electric heating. This installation consists of a "Fridge-Heater," a 2 kW convector and a 1·5 kW fire in the lounge, 2 kW convectors in the dining room, hall and one bedroom, 1 kW convectors in the kitchen and two bedrooms and a Jackson 7 kW electric cooker. In addition, there are a radio set, vacuum cleaner, and, of course, lighting. The owner has had "Fibreglass" placed over all ceilings, but there is no insulation in the brick walls. The meter reading for the 29 weeks since the conversion is 3,490 kWh or 120·4 kWh per week at a cost of 11s per week. The meter reading for the "Fridge-Heater" for 27 weeks is 1,419 kWh or 7 kWh (7·7d) per day. As the walls of the new houses will be insulated against heat loss, a considerable saving on these figures is anticipated.

Our thanks are due to J. S. Holmes & Sons, Ltd., for granting us the facilities for inspecting the houses, and supplying the comparative figures of building costs, and to the Woking District commercial staff of the Board who designed the electrical installation and provided us with the electrical data.

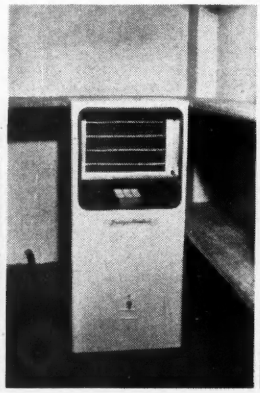
Engineers and Clean Air

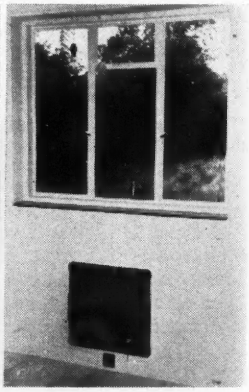
IN view of the major part that must be played by engineers in the application of the Clean Air Act, the Institution of Mechanical Engineers, with the co-operation of other leading technical bodies, has decided to sponsor a conference in London from 19th to 21st February next to deal with practical means of implementing and clarifying the Act's provisions. The president of the conference will be Mr. T. A. Crowe and an opening lecture will be delivered by Sir Ernest Smith.

The organising committee has already drawn up a provisional programme of fifteen papers, five of which will be concerned with electric power stations. The session allocated to the latter will have as its chairman Capt. W. Gregson (who is also chairman of the organising committee). Subjects and authors of this group of papers will be: "Efficient and Smokeless Combustion of Coal and Fuel Oil in Large Boilers," by W. F. Simonson; "Means for Preventing Emission of Grit, Dust and Smoke from Coal-fired Boilers," by D. C. Gunn and P. G. W. Hawksley; "Current Performance and Scope for Improvement in Flue-Gas Washing Equipment," by R. Llewellyn Rees; "Current Performance and Scope for Improvement in Electrostatic Precipitators," by J. S. Forrest and H. J. Lowe; "Mechanical Grit and Dust Collectors," by J. C. Johnson and G. C. Goodwin. The remainder of the papers, divided into three sessions, will relate to preventive measures in other specified industries and to kindred matters, such as "Instruments and Automatic Control" (by Llewellyn Young) and "The Education and Training of Operators" (W. A. Macfarlane). The chairmen of these three sessions will be Sir Ernest Smith, Sir Alexander Fleck and Sir Hugh Beaver. The discussions will be summarised by Dr. G. E. Foxwell. Advance copies of the papers will be available early in the new year at 15s per set or 25s after the opening of the conference.



All-electric houses at Woking showing (left to right) exterior, Dimplex radiator in the bathroom, "Fridge-Heater" in the larder, and a built-in "Thermovent" heater beneath one of the windows





B.E.A.M.A. Publicity Conference

OVER 200 representatives of member-firms of the British Electrical and Allied Manufacturers' Association attended the first B.E.A.M.A. Publicity Conference which was held at the Connaught Rooms, London, W.C.2, on Wednesday last week, under the chairmanship of Mr. C. H. Alsop, chairman of the B.E.A.M.A. Publicity Committee. The object was to bring together those in B.E.A.M.A. firms engaged in publicity, advertising, Press relations, etc., and provide an opportunity for discussing common problems.

There were five "sessions" at which the subjects and speakers were as follows:—"Print and its Use," Messrs. C. H. Chaplain (B.T.H. Co.) and D. G. Denoon (B.I. Callender's Cables), with Mr. C. H. Alsop (W. H. Allen, Sons & Co.) as chairman; "Publicity for the Electrical Industry," Messrs. Claude C. J. Simmonds (Editorial Services) and S. Black (B.E.A.M.A.), with Mr. P. J. J. Roberts (Berry's Electric) as chairman; "Advertising and its Problems," Messrs. E. E. Walker (Metropolitan-Vickers) and V. J. Faulkner (Crompton Parkinson), with Mr. W. L. Allison (Lancashire Dynamo & Crypto) as chairman; and "Exhibitions and Overseas Publicity," Messrs. M. R. Neville (G.E.C.) and A. C. V. Clarkson (G.E.C.), with Mr. C. T. M. Bagnall (English Electric Co.) as chairman. There followed a "Hobby-Horse" session at which brief points were made by Mr. W. A. Wells (Electric Construction Co.), Mr. A. C. Hazel (Hurseal), Miss H. S. O'B. Hoare (Transformers (Watford), Ltd.), Mr. G. A. T. Burdett (B.T.H. Co.), Mr. J. R. Wheating (W. H. Allen, Sons & Co.), Mr. E. K. Cox (Henry Wiggin & Co.), Mr. S. H. Prvor (Metal Industries) and Mr. C. M. G. Peacock (Babcock & Wilcox).

Summing up the conference, the chairman said that the proceedings had made it abundantly clear that technical publicity was a highly specialised job. Some manufacturers in our industry did not realise the big difference between advertising to the technical and the lay public. Mr. Alsop said that above all the publicity man must be a specialist in all the technicalities of his profession.

Speaking at the conference luncheon, Colonel B. H. Leeson, director of the B.E.A.M.A., suggested that the engineer was not usually publicity minded. He found great satisfaction from the equipment he designed and made, and to some extent felt that the fact of achieving these ends was sufficient in itself. However, in a wider sense the engineering profession was coming to recognise the value of publicity, for example, in the attracting of new entrants into the profession. More collective publicity was desirable to help the industry as a whole. He wanted the young to be inspired by the attractive possibilities offered in the electrical industry. In this connection, the B.E.A.M.A. had already published a booklet detailing an amazing number of scholarships and grants made by electrical manufacturers to assist in the education and training of would-be entrants to the industry. At the present time it was particularly important to tell the public about the electrical industry and about its contribution to the well-being of the nation.

Col. Leeson mentioned the collective electrical exhibit being planned for the International Exhibition in Brussels and expressed his pleasure at the B.E.A.M.A. members' response to the appeal made for their support.

New I.T.A. Transmitter

ON Saturday last the fourth television transmitting station of the Independent Television Authority was opened at Emley Moor, near Huddersfield. This station is one of the most powerful Band III transmitting stations in the world and it will serve an area in which nearly 5 million people live.

The station has a maximum effective rated power of 200 kW transmitted from a 16-stack high-gain directional aerial carried on a 445ft self-supporting tower. This directional aerial has a semi-circular radiation pattern which will transmit maximum power in an easterly direction, and this explains why the area served extends about 70 miles to the east but only about 10 miles to the west. By this means the maximum power will be provided in the direction in which it is most needed, and an unnecessary overlap with the Winter Hill service will also be avoided.

Marconi's Wireless Telegraph Co., Ltd., have been responsible for the construction and equipment of the Emley Moor station, and the project was planned and co-ordinated by engineers of the Independent Television Authority.

Letter to the Editor

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Private Generating Plant

I AM indebted to your three correspondents for their helpful letters in your issue of 26th October. In my first letter I omitted to say that one factor which slightly complicates the problem is the mill-owner's house adjacent to the mill, which is at present supplied with d.c. from it. With the advent of television and similar domestic amenities requiring an a.c. supply, it becomes almost essential to either generate or purchase a.c. Assuming the elimination of the battery, the problem, as I see it, resolves itself into five possibilities:—

(1) Abandon the wheel and take all power from the Hydro Board.

(2) Use the existing wheel to drive an induction generator connected in parallel with the Hydro Board's system. This would require the consent of the Board.

(3) Install an ungoverned turbine coupled to an induction generator. This also would require the consent of the Board and a remunerative figure for current returned to compensate for capital outlay.

(4) Install a governed turbine driving a synchronous generator running in parallel with the grid. This would require the consent of the Board, would be fairly costly to install and might require more skilled attention.

(5) Install a governed turbine driving a synchronous generator, with no connection to the public supply. The diesel engine could assist when required.

Perhaps Mr. Ellison or any of your readers may care to comment.

Incidentally, I have been advised by the Board's representative that I had been misinformed regarding the nature of the prohibition placed on the use of the waterwheel. The Board does not forbid the use of the wheel, but it prohibits any mechanical connection between the shafting driven by it and that driven by electric motors. But in the case under review, this almost amounts to the same thing. Deprived of the generator-battery speed control the wheel would be practically useless.

Mr. Ellison wonders if the North of Scotland Hydro-Electric Board will pursue the same policy as the C.E.A. in assisting conservation of the nation's power resources. The letter which I have received from the Board in answer to the induction generator proposal does not convey that impression. While in all respects essentially non-committal, its general tone suggests not so much a body able and willing to help those within its area (the declared aim of the Hydro-Electric Board) as a commercial firm anxious to sell but reluctant to buy.

Rosehall, nr. Keith, Banffs. S. G. LAIDLAW.

PARLIAMENTARY REPORT

Nuclear Power Programme

Mr. Warbey asked the Minister of Fuel and Power what was now the revised estimate of the coal equivalent of the atomic power which would be available in 1965 as a result of recent progress in the research, design and construction of nuclear reactors.

Mr. Jones said that an exact revision of the nuclear power programme must necessarily await the examination of the tenders for the first stations. These were received by the Central Electricity Authority at the beginning of this month.

Mr. Hector Hughes asked the Secretary of State for Scotland if he would make a statement on his plans for the further development of nuclear power for industrial and domestic purposes in Scotland.

Mr. J. Stuart said that apart from the electricity to be supplied from the Atomic Energy Authority's Scottish establishments, the development of nuclear power for industrial and for domestic purposes in Scotland was primarily the responsibility of the Scottish Electricity Boards. The South of Scotland Electricity Board had applied for his consent to the construction of a nuclear power station in Ayrshire.

Later Mr. Warbey asked if the Lord Privy Seal was aware that Sir John Cockcroft had said that there was no technical reason why stage two reactors should not now be planned if supplies of enriched nuclear fuel could be made available, and that, if this were done, in a few years' time we should have an enormous speeding up of the several atomic energy programmes with a saving of coal and oil. Would the Government give the Atomic Energy Authority an assurance that they could now go ahead with plans for stage two reactors on the assumption that, when they were ready to operate, enriched fuel would be released from the military stockpile ?

Mr. Butler replied that the retention of enriched nuclear fuel was not the reason for not going ahead with these reactors. The real difficulty was the speed of research and development, a matter which he had discussed with Sir John Cockcroft when he visited Calder Hall.

Sir James Hutchison stated that, in contrast to what Mr. Warbey had said, it was a fact that stage two reactors had been planned for a long time past.

Manufacturers and Monopolies Report

Mr. Cyril Osborne asked the President of the Board of Trade if he would make a statement on the request by the heavy electrical plant manufacturers to him not to publish parts of the Monopolies Commission's report on that industry and to what extent he estimated that their sales to the Central Electricity Authority had been used to subsidise their export business.

Mr. Derek Walker-Smith, Parliamentary Secretary, said the President was considering the requests which he had received from various quarters that if certain matters were dealt with in the report they should be excised before publication. As for the second part of the question, Mr. Osborne should await publication of the report and not draw any inference about its contents from statements reported in the Press.

Common Currency

Replying to Mr. Osborne, the Chancellor of the Exchequer said it was not necessary for the successful operation of a European Free Trade Area that there should be a common currency and the Government did not contemplate taking part in any arrangements of this kind, even if such arrangements were proposed, in view of our wider responsibilities with regard to sterling.

Radiation Hazards

Mr. Robert Carr, Parliamentary Secretary, Ministry of Labour, told Mr. Airey Neave that the Factory Inspectorate included at headquarters a physicist engaged full-time in advising the Inspectorate and industry on precautions to be taken with regard to radiation hazards. All factory inspectors were supplied with information on this subject. One engineering inspector was at present attending a course on the design of nuclear reactors. The Inspectorate was informed by the Atomic Energy Authority of all firms to which radioisotopes were delivered.

Radio Industry Unemployment

Mr. Iain Macleod, Minister of Labour, gave Mr. Hunter the latest figures for unemployment in the radio industry. He said that on 17th September there were 901 people unemployed in the radio apparatus and gramophone industry, and 333 in the radio valve and electric lamp industry.

Clean Air Act

Mr. Duncan Sandys, Minister of Housing and Local Government, informed Mr. Dodds that an Order under the Clean Air Act would shortly be laid before Parliament specifying the appointed day for the provisions which dealt with smoke control areas, new furnaces, the height of chimneys, the appointment of Clean Air Councils, and certain other matters. It was intended that the remaining provisions of the Act, dealing with emissions of dark smoke, grit and dust from industrial premises, railway engines and vessels should be brought into force in the early part of 1958. Meanwhile arrangements had been made for warnings to be broadcast by the B.B.C. this winter if and when persistent fog was forecast, with advice to the public about the steps they should take. Householders and industry would be asked to take special care to minimise smoke.

Dutiable Imports from Commonwealth

In reply to Mr. Holt, the President of the Board of Trade (Mr. Peter Thorneycroft) gave details of certain goods imported into the United Kingdom from Commonwealth countries in 1955 on which protective duties were paid at preferential rates. These included electrical machinery, apparatus and appliances worth £3,812, on which duty amounting to £825 was paid.

Commercial Television in South Wales

Mr. Alport told Mr. Ness Edwards that St. Hilary Down, Glamorgan, had been chosen as the site for a commercial television transmitter for South Wales. It was proposed to allocate Channel 10 for the purpose but final clearance was awaited from the Continental administrations concerned.

Oil Supplies and Trolley-Buses

Mr. Palmer asked the Minister of Transport whether, in view of the desirability of limiting as far as practicable the import of fuel oil, and the desirability of not adding further to the volume of diesel fumes in the congested London area, he would give a general direction to the British Transport Commission to disallow the decision of the London Transport Executive to spend over £10 million on the purchase of diesel buses in substitution for existing electric trolley-buses worth approximately £20 million.

Mr. Harold Watkinson: "No, sir. The additional consumption of diesel oil will be comparatively insignificant."

Overseas Trade Fairs

Mr. Leavey asked the President of the Board of Trade what further arrangements he was making to review the policy of his department regarding overseas trade fairs and exhibitions.

Mr. Peter Thorneycroft said he had asked the Minister of State (Mr. Low) to act as chairman of a committee to advise him on this matter, consisting of Mr. R. P. S. Bache, Mr. J. E. C. Bailey, Mr. W. B. Beard, Sir Ernest W. Goodale, Mr. John McLean, Mr. F. Rostron, Sir Cecil Weir and Mr. W. J. Worboys. In addition, the Foreign Office, Commonwealth Relations Office and Board of Trade were represented by senior officials on the committee which had recently held its first meeting.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

The A.E.I. Lamp & Lighting Co., Ltd., announces that as **Mr. V. C. H. Creer,** M.A., has ceased to be joint managing director, **Mr. S. R. Eade,** M.I.E.E., has been appointed sole managing director and **Mr. J. Clement,** B.Sc., sales director.

Mr. Eade was appointed joint managing director in 1955. He joined the B.T.H. Co., Ltd., as an engineering apprentice in 1924 and was on the staff of the Research Laboratory from 1929 until he became lamp works engineer in 1939. He was appointed manager of the Leicester Lamp Works in 1945 and manager of all the B.T.H. lamp factories in 1949.

Mr. Clement completed his engineering apprenticeship with the B.T.H. in 1928 and was appointed district office manager at Newcastle-upon-Tyne in 1936. In December, 1946, he was transferred to the Birmingham office as manager, a position which he held until 1955 when he was appointed assistant sales manager of the B.T.H. Co.

Mr. John W. Simpson, O.B.E., F.C.I.S., F.S.S., secretary of the British Electrical Power Convention, has been elected the first chairman of the newly formed Institute of Conference Management. This Institute has as members organisers of association and other conferences who have founded it as a means of exchanging experience and improving the standard of conferences.

The governing body of the Northampton Polytechnic Institute has appointed **Dr. J. S. Tait,** B.Sc.(Eng.), M.I.Mech.E., M.I.E.E., principal of the Northampton Polytechnic Institute and director of the National College of Horology, in succession to **Dr. J. E. Richardson,** who becomes director of the Regent Street Polytechnic. Dr. Tait is at present principal of the Woolwich Polytechnic, London, and he will take up his new duties early in 1957. He received his technical education at the Kilmarnock Technical School, and the Royal Technical College, Glasgow, where he gained the diploma with distinction in electrical science. He also obtained the B.Sc.(Eng.) degree, with first class honours, of the University of London, as an external student. Later he was awarded the degree of Doctor of Philosophy in the University of Glasgow. His academic career as a lecturer at the Royal Technical College, Glasgow, was followed by a period as head of the Electrical Engineering Department at Portsmouth Municipal College, before he joined the Northampton Polytechnic Institute as head of the Electrical Engineering Department in 1947. He was elected a member of the University of London Board of Studies in Electrical Engineering and he has taken an active part in university work since.

Dr. J. S. Tait

Mr. Frederick A. Haigh, B.Sc., has retired after fifty-one years' service with the British Thomson-Houston Co., Ltd. On leaving King William's College, Isle of Man, Mr. Haigh went to Owen's College, Manchester, where he graduated as a B.Sc. (Physics) with honours. He went to Rugby in 1904 for a special three-year apprenticeship course and joined the D.C. Engineering Department (now the Plant Engineering Department) in 1910. Mr. Haigh has been closely associated throughout the whole of his professional life with the development of a.c./d.c. converting machinery and has been responsible over many years for the design of B.T.H. motor and rotary convertors.

Mr. F. A. Haigh

As a result of the retirement of **Mr. J. E. Macpherson** for reasons of health, the board of Vitality Bulbs, Ltd., makers of miniature electric lamp bulbs, has been reorganised. **Mr. W. H. Blaxland,** F.C.A., becomes chairman and **Mr. Michael Cleminson,** managing director of Cleminson's Agencies, Ltd., is appointed to the board. This renews an old association since Mr. Cleminson's father founded the business and managed it until his death. **Mr. T. D. Willcock,** F.I.A.C., company secretary, who has been with the company since its inception, and **Mr. H. L. Malec,** A.R.C.S., B.Sc., the present general manager, also become directors. **Mr. F. L. Richmond,** who joined the firm in 1945, remains sales manager.

Mr. A. M. Scales has retired from the service of Thorn Electrical Industries, Ltd., at the age of seventy. Last week he was presented with a television set by Mr. J. G. Christopherson, general sales manager of the Atlas Lighting Division, on behalf of his colleagues and with a cheque from the company by Mr. A. S. Shier, sales director of Thorn Electrical Industries.

Mr. Richard L. Hearn, B.A.Sc., D.Eng., is retiring from the position of chairman of the Hydro-Electric Power Commission of Ontario which he has held since the early part of 1955. He was formerly general manager and chief engineer of the Commission whose Toronto steam power station is named after him. Dr. Hearn's successor as chairman is **Mr. J. S. Duncan,** a Canadian industrialist who was formerly president and chairman of the Massey-Harris-Ferguson concern.

Dr. R. L. Hearn

Mr. G. D. Worthington, sales director of Cable Covers, Ltd., left England on 1st November on a visit to electricity supply authorities in East and South Africa and the Rhodesias.

Mr. W. P. Port, who has represented Falk, Stadelmann & Co., Ltd., for forty-two years, has retired. In recent years he has represented the company in the Gloucestershire, Berkshire, Reading and Oxford areas.

Mr. M. C. Blythe, M.I.E.E., returned from Australia on 17th October to take up the appointment of sales director, Doulton Industrial Porcelains, Ltd. He will be primarily responsible for home and export sales of h.v. insulators, and will not be immediately concerned with the filters and chemical stoneware also made at the factory at Tamworth. He will be at Doulton House, Albert Embankment, London, S.E.1. For the past eleven years Mr. Blythe has been with the Brush Group, having been successively assistant manager, London office, branch manager, Newcastle-on-Tyne, and director, Brush Electrical (Australia) Pty., Ltd.

Mr. M. C. Blythe

Mr. J. D. Chittleburgh, M.B.E., has been appointed an additional director of E. Shipton & Co. (Holdings), Ltd.

Mr. R. Taylor, previously home and export sales manager of Aron Elec-

tricity Meter, Ltd., has been appointed general sales manager and **Mr. D. E. Sargeant** and **Mr. L. C. Wright,** both of whom recently joined the company, have been appointed home sales manager and export sales manager, respectively.

Mr. J. R. Arundale has retired from the office of secretary of Simon-Carves, Ltd., because of ill-health and **Mr. R. S. Helliwell,** M.A., A.C.A., the company's accountant, has been appointed secretary in his place.

At a meeting of the National Inspection Board held on 1st November **Mr. C. R. King,** C.B.E., Comp. I.E.E., M.Inst.F., was elected chairman of the Board and of the National Inspection Council in place of the late Mr. P. V. Hunter, C.B.E. Mr. King, who is chairman of the East Midlands Electricity Board, was appointed deputy chairman of the National Inspection Board at its first meeting held on 27th August last at the same time that Mr. P. V. Hunter became the first chairman.

Mr. C. R. King

The eleventh annual dinner of the **J. & P. Foremen's Association** was held at Woolwich on 26th October when there was a record attendance. Mr. S. Simmons, chairman of the Association, in proposing the toast of the company, said this was an important year in its history. He referred to the smooth transition, over the short period of 18 months, of the Sheet Metal and Switchgear Departments to the new Elizabeth Works at New Cross. Congratulating Mr. G. Leslie Wates, J.P., Comp.I.E.E., on his 25 years as chairman of the company, Mr. Simmons asked him to accept a commemorative plaque which would be placed in the J. & P. Sports Ground at Kidbrooke at the side of a row of flowering cherry trees planted by the Foremen's Association to mark the occasion, and he asked Mr. Wates—who is a keen horticulturist—to plant the last one of them on the following day.

Mr. G. Leslie Wates planting one of a row of flowering cherry trees at the Johnson & Phillips sports ground at Kidbrooke to commemorate his silver jubilee as chairman of the company. He is being assisted by the groundsman. Mr. S. Simmons, chairman of the J. & P. Foremen's Association, is on the right

Expressing his thanks, Mr. Wates said the presentation had come as a complete surprise to him.

Mr. G. T. Whitehead, O.B.E., works director, proposing the toast of the Foremen's Association, stressed the need for ensuring an increase in the supply of craftsmen and said we must pay particular attention to the instruction of youth in our care. Mr. J. Hayward responded. The toast of the guests was given by Mr. F. G. Crichton, who welcomed Mr. W. Glass, managing director of J. & P. and Dr. Smith, a director of Telcon. The response for the guests was made by Mr. A. E. Wollaston in a short and witty speech.

The annual social gathering of the **Metropolitan-Vickers Long Service Association** was held on 29th October in the staff canteen at Trafford Park Works, and was attended by Viscount Chandos, in his capacity as president of the Association. About 1,100 members of the Association were present, all having thirty years' or more service with the company. Lord Chandos addressed the gathering, and the ladies' toast was proposed by Dr. C. Dannatt, managing director.

Lord Chandos, president of the M.-V. Long Service Association, chatting with lady members. With him are Mr. R. H. S. Turner, director and works manager (left), and Dr. C. Dannatt, managing director (right)

Increased salaries for electrical power engineers were referred to by Mr. L. Benallick, president-elect of the **Electrical Power Engineers' Association,** at a dinner of the Midlands Division of the Association held in Birmingham on 26th October. Mr. Benallick said that the Association's claim was not a wage claim in the ordinary sense but "a request for reconsideration of the structure of salary scales and arrangements." This was desired to provide for changes in the duties performed by the power engineers. They were not going forward with other unions in the race for wages. Mr. F. D. Felton, managing director of the Revo Electric Co., Ltd., expressed regret that there had been a postponement of a section of the new generating plant programme as part of the economies in capital investment.

Mr. R. L. Burrows has been appointed product manager for hearing aids in the Electrical Appliances Division of Philips Electrical, Ltd. From 1948 until taking up his present post Mr. Burrows was the technical representative of Philips Electro-Acoustic Division in the North-West of England.

OBITUARY

Sir Francis Simon.—The death occurred on 31st October, at the age of sixty-three, of Sir Francis Simon, C.B.E., F.R.S., Dr. Lee's Professor of Experimental Philosophy and former Professor of Thermodynamics in the University of Oxford. Sir Francis came to this country from Breslau in 1933 and was responsible for building up the low-temperature physics group at the Clarendon Laboratory. He took a great interest in fuel efficiency and the conservation of coal and was concerned with atomic energy development for many years.

Mr. M. Campbell.—The death has occurred, at the age of eighty, of Mr. M. Campbell who, up to the time of his retirement in 1943, had been transport manager of the General Electric Co., Ltd., for twenty-four years. Mr. Campbell was one of the earliest members of the G.E.C. Social and Athletic Club and, indeed, was largely responsible for its success.

Mr. F. D. Newcombe, founder and director of F. D. Newcombe & Co., Ltd., electrical and radio wholesalers, Exeter, died on 2nd November. Mr. Newcombe was born at Barnstaple in 1890 and after being apprenticed in the ironmongery trade had retail stores experience in London from 1910 to 1914. He served in R.E. Signals during the first world war and founded F. D. Newcombe & Co., in 1926. He was president of the Radio Wholesalers' Federation in 1948-49, and chairman of the S.W. Area Council of the National Chamber of Trade in 1947. He was elected to the Exeter City Council in 1936 and became an alderman in 1949.

Mr. G. D. Clegg, who was superintendent of Nechells power station up to his retirement two years ago, died on 27th October in West Bromwich District Hospital. Mr. Clegg had spent nearly 50 years in the electricity supply industry, mostly in Birmingham. A prominent member of the Electrical Power Engineers' Association, he was for many years a member of the national executive and also served as Midland divisional council secretary and as chairman of the Midland managerial section.

Trading Agreements Registration

THE Registrar of Restrictive Trading Agreements has made regulations under the Restrictive Trade Practices Act, 1956, which specify the documents to be sent to him for the purposes of the register. Briefly, these are any document constituting an agreement or part of it and a memorandum setting out any terms of an agreement and the names of any parties to it which are not in such a document. Four copies of all documents will be required, three for the registers themselves and one for the use of the Registrar's Office. These documents must be accompanied by a certificate on a form to be issued by the Registrar stating that they contain the whole of the terms of the agreement and the names of all parties to it. The forms will be available in a few days' time.

The period allowed for the sending of particulars of agreements of the classes "called up" by the Board of Trade's Order of 2nd August is from 30th November, 1956, until 28th February, 1957.

A guide to registration has also been prepared and was published on 1st November. The guide is necessarily a "technical handbook" in form, and is intended less for the general reader than to help those required to furnish particulars of agreements.

The register of agreements, when it is prepared, will be maintained in London, Edinburgh and Belfast. It will be open to inspection by any member of the public for the fee of 1s per day. The publications referred to are as follows and are obtainable from H.M. Stationery Office:—Registration of Restrictive Trading Agreements Regulations, 1956, price 4d (by post 6d); Registration of Restrictive Trading Agreements Order, 1956, price 3d (post 5d); Guide to the Registration of Agreements under Part I of the Restrictive Trade Practices Act, 1956, price 1s (by post 1s 2d); Registration of Restrictive Trading Agreements (Fees) Regulations, 1956, price 3d (by post 5d).

Management Problems

ONE of the papers read at last week's conference at Harrogate of the British Institute of Management was "Effective Communication in Industry," by Mr. R. H. Coates, controller, Southern Division, C.E.A. In this Mr. Coates referred to the prodigious increase in methods of communication and the number of communications which had led to serious congestion. He suggested that one way of tackling this situation was to measure everything that was measurable and that analogous problems which had been met and solved elsewhere should be studied; Mr. Coates instanced large public libraries, public telephone systems and the human brain which all involved systematic storage, multiple selection equipment and individual use of equipment. He proceeded to show how these principles were applied to the organisation and administration of his Division.

Mr. D. W. Morphy, joint managing director, Morphy-Richards, Ltd., presented a paper on "The Design Function—Gap or Bridge Between Sales and Production?" In this he defined "design" as covering the whole evolution of a product from inception to sale and described a routine devised to cover the sequence of activities in his own organisation.

Nuclear Generating Station for Ayrshire

THE South of Scotland Electricity Board announces that it has submitted to the Secretary of State for Scotland applications for his consent to the construction of a nuclear generating station under Section 2 of the Electric Lighting Act, 1909, and for the necessary permission. The official notice, published on 5th November, states that the plans and other particulars may be inspected at the public offices of Ayr County Council in Ayr, at the District Council offices at Saltcoats and West Kilbride, at the Board's head office in Glasgow, at St. Andrew's House, Edinburgh, and Dover House, London, and that any objection will require to be submitted to the Secretary of State by 26th November. The Board has also made a compulsory purchase order in respect of the land required.

Referring to its plans for constructing a nuclear generating station, the Board says that it has in mind the prospect of a cheaper source of power and of bringing to Scotland at the earliest possible stage the new knowledge and technique. While the capital costs of a nuclear station are higher, the running costs are much lower than for a coal-fired station, thus facilitating the further development of off peak loads and making pumped storage schemes practicable. In this respect Scotland has unique natural advantages, particularly in the north, which cannot be exploited until there is available a cheap source of night energy such as will be provided by a nuclear station. The Board hopes in co-operation with the North of Scotland Hydro-Electric Board, to develop schemes of this kind.

The proposed station will contain two nuclear reactors of the graphite-moderated gas-cooled type, capable of providing sufficient heat to generate from 250,000 to 300,000 kW. It is hoped to commission one half during 1961 and the other half in 1962. The station will operate at a very high load factor and will provide approximately one-quarter of the total energy required in the south of Scotland. Uranium fuel will be obtained from the Atomic Energy Authority, and returned to them after irradiation for processing and recovery of the valuable by-products.

Messrs. Kennedy & Donkin have been appointed as consulting engineers, and tenders have been invited from four groups of manufacturers in each of which Scottish firms are represented. These groups are the Nuclear Power Plant Co., Ltd., headed by C. A. Parsons & Co., Ltd.; the A.E.I.-John Thompson Nuclear Energy Co., Ltd.; the General Electric Co.-Simon-Carves group; and the English Electric Co. and Babcock & Wilcox group.

Speaking in Glasgow last week, Mr. J. S. Pickles, chairman of the South of Scotland Board, said that work on the station would be started early in the spring. It would cost between £35 and £40 million. About 90 acres of land would be used, and the buildings would be functional in character, smaller than in a normal coal-fired station and with a glazed rectangular exterior; there would be no railway sidings, cooling towers or coal stacks and no water towers.

Industry in Northern Ireland

AN additional £10,000,000 to aid new and established industry in Northern Ireland is proposed in the Capital Grants to Industry (Amendment) Bill which was to be read a second time in the Belfast Parliament on Wednesday last. The Bill extends for a further five years the 1954 Capital Grants to Industry Act which authorised an expenditure of £5 million. The amended Act will continue to provide new and existing firms for a further five consecutive years with grants toward investment in new buildings and new and second-hand plant and machinery installed in Northern Ireland. The initial rate of grant is to be 25 per cent. Capital grant payment to a new firm in any one year will be limited by the Bill to 25 per cent of £400,000 expenditure on plant and machinery and 25 per cent of £200,000 on industrial buildings.

Electricity Reorganisation

The Queen's Speech at the opening of the new Session of Parliament on Tuesday contained a forecast of a Bill for the reorganisation of the electricity supply industry in England and Wales, based on the recommendations of the Herbert Committee.

Her Majesty also said that a measure would be laid before Parliament to replace the existing emergency powers in respect of hire-purchase and hiring agreements and to regulate borrowing by hire-purchase finance companies.

INDUSTRIAL NEWS

Small Nuclear Reactors

A "homogeneous" nuclear reactor (one in which the fuel and coolant are combined in the form of a solution) is being developed by the Hawker Siddeley Nuclear Power Co. formed a short time ago. The managing director of the Hawker Siddeley Group (Sir Frank Spriggs) said last Monday that the first stage of a large experimental programme was nearing completion; it has involved the establishment of a well equipped metallurgical laboratory at Langley, Bucks., and the building up of a first-class design team.

Sir Frank Spriggs said that one of the company's activities in the immediate future would be the development of advanced types of reactors for electricity generation. There were vast possibilities for this country in the supply of small, easily transportable, reactors for countries which would not be in a position to build their own for some time.

It was explained by Mr. E. P. Hawthorne, chief executive of the Hawker Siddeley Power Co., that while they naturally had an interest in the application of nuclear power to aircraft they saw useful prospects in the supply of small electricity-generating plants for remote areas, as well as reactors for marine propulsion and for providing process heat. The starting point in progress towards higher temperatures in reactors were metallurgical and the company was actively engaged in metallurgical investigations.

Courtney, Pope Manchester Showrooms

New showrooms were opened by Courtney, Pope (Electrical), Ltd., on 31st October at 18, Chatham Street, Piccadilly, Manchester, by Mr. L. R. Courtney (chairman of the group), supported by Mr. A. H. Olson (managing director of Courtney, Pope (Electrical), Ltd.), who were accompanied by their ladies. A large number of guests attended the opening ceremony. The showrooms display a cross-section of the lighting products manufactured by the company, and they are primarily intended for the use of architects, consultants and electrical contractors. The staff is under the direction of Mr. J. E. Tonge, who has been appointed northern area manager to the company.

A section of the new lighting showrooms opened by Courtney, Pope (Electrical), Ltd., in Manchester

Transformer Manufacture in Scotland

Ferranti, Ltd., announce that they will shortly manufacture distribution transformers in Inverness. This decision has been made as a result of discussions between Mr. Thomas Johnston, chairman of the North of Scotland Hydro-Electric Board, and the company. The Board has placed an order with Ferranti, Ltd., for a number of transformers for electricity distribution schemes, which will be the first to be manufactured under this arrangement. The company already employs over 2,600 people at its Edinburgh and Dundee Works.

Australian Tariff Inquiry

The Australian Minister for Trade has referred to the Tariff Board for inquiry and report the question whether assistance should be given to the local production of electric floor polishing machines, including those capable of scrubbing and vacuum cleaning. United Kingdom Trade Associations wishing to give evidence must notify the Australian authorities by 19th November and the Commercial Relations and Export Department of the Board of Trade, Horse Guards Avenue, Whitehall, S.W.1, should be notified (reference C.R.E. 11785/56).

Switchgear for High Marnham

A large contract for auxiliary switchgear for the new C.E.A. power station at High Marnham, on the River Trent, has been awarded to Ferguson Pailin, Ltd. This station, when completed, will be the largest single station in this country; the ultimate capacity will be 1,000 MW from five 200 MW machines, the first set being due for commissioning in 1959.

Power will be supplied from this station to the grid at 275 kV. The station auxiliaries will be operated on 6·6 kV and 415 V. The 6·6 kV Ferguson Pailin switchgear is to have a rating of 350 MVA and will be of the compound filled, vertically isolated, single busbar type. The switchboards will comprise initially a 19-panel station transformer board, with three 8-panel unit boards and three 11-panel boiler boards.

The station transformer switchboard and certain circuit-breakers in the unit switchboard will be controlled from a 28-panel combined control and relay board in the station control room. Relays associated with the remainder of the switchgear will be mounted on relay panels in the unit control rooms.

Calder Hall Inspection

After running for about seven weeks the Calder Hall nuclear power station was temporarily taken out of service this week for inspection purposes. It is believed that the fuel elements and the CO_2 cooling system are being examined and the rest of the plant checked over. Since the Queen formally inaugurated the station on 17th October Calder Hall has been feeding between 10 and 20 MW into the grid.

Trade Effluents

The Central Advisory Water Committee held its second meeting in London on 30th October at the Ministry of Housing and Local Government, the chair being taken by the Parliamentary Secretary to the Ministry, Mr. J. Enoch Powell. It was decided to establish a third Sub-Committee, on the disposal of trade effluents.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £197 0s 0d
COPPER, H.C. Electro	ton £284 10s 0d
Fire Refined 99·7%	ton £283 0s 0d
Fire Refined 99·50%	ton £282 0s 0d
COPPER Tubes ..	lb 2s 9½d
Sheet	ton £368 0s 0d
H.C. wire and strip ..	ton £333 15s 0d
LEAD, English ..	ton £117 5s 0d
Foreign	ton £116 0s 0d
MERCURY	flask £83 10s 0d
TIN, block (English) ..	ton £878 0s 0d
ZINC, G.O.B. Foreign	ton £99 15s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)	lb 2s 3⅜d
Sheet	ton £300 10s 0d
Wire	lb 3s 0½d
PHOSPHOR BRONZE Wire	lb 4s 5½d
PLATINUM	oz £34 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 29⅞d—30⅛d

Colour in the Kitchen

Hitherto the range of domestic appliances produced by the English Electric Co., Ltd., have been available

only with cream or white enamel finish. Now the company has introduced colour relief, employing three pastel shades—aquamarine, candy pink and lavender—and grenadier red. The colour is applied only to easily replaceable parts, i.e., the refrigerator door, the table top of the washing machine, and the hob of the company's raised cooker. The English Electric mixers are also being made with cases in these colours.

It will be seen that it is now a fairly simple matter to have appliance parts replaced to conform with changes in kitchen décor.

Electrical Engineers Exhibition

The Minister of Education, Sir David Eccles, will open the sixth Electrical Engineers Exhibition at Earls Court on 9th April next, and he will also be guest of honour at the subsequent luncheon. The exhibition will include a stand depicting "Education in the Electrical Industry, Government Services and Educational Institutes." This will cover nearly 7,000 sq ft and will be supported by the Association of Supervising Electrical Engineers, the Borough Polytechnic, the B.B.C., the Central Electricity Authority, the City and Guilds Institute, the General Post Office, the Institution of Electrical Engineers, the Northern Polytechnic and twelve electrical companies' educational displays.

A trade film premiere of the Fifth Electrical Engineers Exhibition will be held at the Building Centre, Store Street, Tottenham Court Road, W.C.1, on 21st November at 3 p.m. and 6 p.m. Admission will be by ticket which can be obtained on application from Mr. P. A. Thorogood, general manager, Electrical Engineers (A.S.E.E.) Exhibition, Ltd., 6, Museum House, 25, Museum Street, London, W.C.1.

New Furse Wholesale Showroom

A new trade showroom for domestic electrical appliances and lighting fittings was opened by Furse Wholesale, Ltd., at Canal Street, Derby, on 23rd October. This is part of new premises of approximately 7,000 sq ft which also includes a trade counter, offices, and stores, to which the company moved recently from London Road, Derby. The showroom, covering an area of 1,000 sq ft, is one of the most up-to-date in the Midlands and, it is claimed, is the only one of its kind in Derby. It was well attended by trade friends during a special three-day opening display, which included equipment by some of the larger domestic appliance manufacturers. Visitors to the showroom were welcomed by Mr. T. C. Bond and Mr. P. M. Furse, directors of the company.

Part of the new trade showroom opened by Furse Wholesale, Ltd., in Derby

Australian Imports

Indications of the results of the cuts in import quotas can be seen in the latest statistical information from South Australia, where imports of dynamo-electric machinery from overseas in July, 1956, were valued at £344,779 in comparison with the £407,873 in July, 1955.

Imports from overseas into Western Australia in the nine months ended 31st March last (with those for the corresponding period to 31st March, 1955, in parentheses) included: Covered electrical cable and wire, £59,928 (£98,886); batteries, £12,409 (£11,467); electric lamps and tubes, £32,742 (£52,574); radio equipment, £25,036 (£8,465); telephone and telegraph equipment, £144,733 (£69,692); electrical heating and cooking appliances, £50,065 (£88,590); current generating machines, £257,107 (£64,452); electric motors, £241,163 (£137,477); and other electrical equipment, £462,447 (£331,442).

French Productivity Team's Visit

A French mission visited this country in October with the object of studying rural electrification from the angle of network planning, design and construction, and also the commercial policy as applied in this country. The delegates spent four days with the Southern Electricity Board, one day in discussion at headquarters and three days touring the Newbury and Bournemouth Sub-Areas to see lines, substations and farms.

Members of the French Rural Electrification Productivity Team at the S.E.B. headquarters, Maidenhead. Left to right: Messrs. H. R. J. Baigent, J. R. Bennett, Simon Rabu, R. A. Woods, Pierre Travassac, R. B. Sully, S. M. Rix, A. N. Myles, R. H. Abel, Marc Neveux, Henri Dessage, R. R. B. Brown, Jean Touzé, W. B. Poulter, Guy Sellier, Francois Lamouroux, Mrs. Hippisley, H. W. Taylor, H. Norel, G. Hicks, K. L. May, C. A. Cameron Brown, F. W. Kempton, and R. Birt

Benjamin Drip Mats

A set of three drip mats in a "Cellophane" packet, suitable for table use in works canteens, etc., has been produced by the Benjamin Electric, Ltd., Brantwood Lane, Tottenham, London, N.17. These bear advertisements of the company and we are informed that supplies will be forwarded free of cost to interested readers.

Fatal Shock from Blanket

At Bradford on 30th October a verdict of death by misadventure was recorded on William Comrie (22), of Wibsey, who died after receiving a shock from an electric blanket. A police surgeon said that Comrie was suffering from diabetes and the blanket was wet.

Mr. Alfred Fisher, an engineer with the Yorkshire Electricity Board, said that the insulation had been made ineffective by the damp. There were some blankets which were designed to be slept in when switched on but this was not that type because if it was damp it was dangerous. Even perspiration might make it dangerous, or the normal damp absorbed into the bed.

The coroner said that it was unwise to lie on a bed with the blanket switched on. It was safer to warm the bed first and then switch the blanket off.

A.S.E.E. Diploma Scheme Examinations

The Executive Council of the Association of Supervising Electrical Engineers announces that the 11th annual examinations to be held under its diploma scheme will take place at

various centres throughout Great Britain on 22nd and 23rd May next year. The last date for receipt of applications to sit the examinations is 1st March. A folder giving details of the scheme can be obtained from the general secretary of the Association, 23, Bloomsbury Square, London, W.C.1.

Christmas Lighting Sets

Crompton Parkinson, Ltd., have again built up stocks of two sets of decorative Crompton lamps for the Christmas trade—one, a set of decoration lights comprising a string of twelve assorted colour cone-shaped lamps, and the other, a set of party lights containing twelve clear lamps with white and coloured bell-shaped shades bearing nursery rhyme transfers. Both sets are in attractive cartons and are supplied ready wired, and complete with b.c. adaptor, fixing devices and one spare lamp. Also being made available are packs of twelve spare coloured lamps for the decoration light sets. These, also, are attractively boxed, and are designed for display on shelves or counters.

Crompton Christmas decoration lighting sets

Technical Student Exchanges

The ninth annual report of the International Association for the Exchange of Students for Technical Experience shows that in 1956 there was an overall exchange of 5,711 technical students between the 22 member countries, as compared with 5,153 in 1955.

The following selected countries sent out and received, respectively, the total numbers of students indicated: Germany, 1,284 and 1,019; Great Britain, 743 and 774; the United States of America, 58 and 76.

Of a total exchange of 833 electrical engineering academic students, Germany sent out 136 students, Great Britain 82 and the United States 7. Corresponding figures for civil engineering were 92, 125 and 4; and for mechanical engineering 279, 158 and 13. The electrical engineering industries in the selected countries received the following numbers of students: Germany 152, Great Britain 151 and the United States 25.

In Great Britain there are now 34 universities and colleges affiliated to I.A.E.S.T.E. and about 300 companies and other industrial organisations, including many electrical concerns, participate in the work of the Association.

Batti-Wallahs' Society

Industrial relations in America and Britain formed the subject of the instructive talk given by Sir Archibald Gordon (at one time Counsellor and Labour Attaché, British Embassy, Washington) at last week's luncheon of the Batti-Wallahs' Society, over which Mr. W. C. M. Couch (president) presided.

Sir Archibald indicated the difference in outlook of the British and American trade union movements. In America there was no Labour Party and the trade unions were not concerned with political activities. While most agreements in Britain were national, in America, owing to its size, agreements were generally local and often between individual firms and the men. This system had its advantages. The men were interested in their firm's prosperity and gave full co-operation in increasing output, in the anticipation that they would share in the increased profits. This was one of the reasons for the higher productivity in America.

Mr. T. C. F. Bigland announced that the guest speaker at the next luncheon (Thursday, 29th November) would be Mr. J. Eccles, who would talk on his visit to Russia.

Electrification of Epping-Ongar Line

London Transport announced last week that a start is to be made early next year on electrifying the six-mile section of the Central Line beyond Epping to North Weald, Blake Hall and Ongar. The work will take between twelve and eighteen months and will cost £100,000.

The " Electrical Wholesaler "

Mr. A. B. Wildsmith tells us that the autumn number of the *Electrical Wholesaler*, published by the Electrical Wholesalers' Federation, will be the last. It is possible that at some future date a similar publication will take its place.

Millionth Jackson Cooker

Earlier this year we referred to the production of the millionth cooker by the Jackson Electric Stove Co., Ltd. Mr. Wilfred Pickles, who was asked to select a worthy recipient, had had a request from a blind housewife for a cooker with braille markings. When it found that the blind housewife came from Nottingham, the East Midlands Electricity Board offered to provide a cooker circuit should it prove necessary and deliver and install the cooker. Jacksons provided the switches and controls with braille markings, and also the " Cookalone " automatic readings as well. The recipient was Mrs. Ivy Clayton, of Mapperley, Nottingham.

South Western Arts and Crafts Exhibition

An Arts and Crafts Exhibition organised by the South Western District Joint Advisory Council of the Electricity Industry was held at Electric Hall, Torquay, on 3rd, 5th and 6th November. Nearly 300 entries from all over the South West were received. At the opening visitors were welcomed by Mr. A. C. Thirtle, divisional controller of the South Western Generating Division of the Central Electricity Authority, and Mr. E. C. Willis, deputy chairman of the South Western Electricity Board. Prizes were awarded for the best entries in each class and most of the prize-winning and commended entries will be shown at a national exhibition to be held at Bellevue, Manchester, early next year. The 26 classes included oil paintings, water colours, photographs, literature, woodwork, models, toys, needlework, tapestry, textiles, knitting, crochet work and children's artwork.

Transmitters for Pakistan

Following closely on the announcement of the formation of their new communications company, the Cossor Group have now received a substantial order for transmitters for Pakistan. The contract amounts to £170,000 and is supplementary to the £250,000 order for similar fixed and mobile h.f. equipment placed three years ago.

Trade Announcements

Lumenated Ceilings, Ltd., is now being represented in the north-east area by the parent company, Thermotank, Ltd., and in future all local inquiries will be dealt with by Mr. R. E. M. Wilson, Thermotank, Ltd., Tyneside Works, Bede Trading Estate, Jarrow-on-Tyne, Co. Durham (telephone: Jarrow 89-7171).

Dowsing Company (Electrical Manufacturers), Ltd., announce that they are unable to accept further orders this season for electrically heated blankets, the company manufacturing this article having gone into voluntary liquidation. This, however, in no way affects the supplies of products manufactured by Dowsing Company (Electrical Manufacturers), Ltd.

The **Wessex Wholesale Electric, Ltd.,** has purchased the depot of the Supra Electrical Co. at 50, Vyvyan Street, Camborne (telephone: 3028). The services of Mr. F. W. Harris have been retained, and Mr. R. Capham will continue to represent the Wessex company.

Babcock & Wilcox, Ltd., are now at Babcock House, 209, Euston Road, London, N.W.1 (telephone: Euston 4321).

Free Piston Gas Turbines for Power Generation

Their Future Role Relative to the Use of Supercritical Steam Conditions

By S. B. JACKSON*

WITH the successful development of the free piston gas generator it would appear that a new prime mover is available to generation engineers, permitting high efficiency large-scale electricity generation.

As there is abundant literature on the theory and practice of free piston gas generators, it is not intended to refer to them here. As an indication, however, of the progress achieved, it may be stated that there are now more than 102 free piston gas generators totalling 102,000 h.p. in service, and operating experience under a wide range of conditions is accumulating at the rate of 750,000 hours per annum. Many of these gas generators are operating under more adverse load and temperature conditions than are likely to be experienced in this country. Regarding electric power generation, four sets are in operation including a 6,000 kW machine at the Electricité de France power station, Cherbourg. Further, electric generating sets now in course of construction, including two repeat 6,000 kW sets for Electricité de France, total over 26 MW capacity.

It might be considered that this experience does not inspire confidence to order larger sets, but having regard to the fact that there are at least two 15 MW aerocompressor machines in service in this country, this alone should be taken as favourable. In the aerocompression type of machine for the duty indicated the turbine equivalent output is about 36 MW of which 21 MW is required for air compression and 15 MW for the load. It would thus appear that with the simplicity and other technical advantages of the free piston gas generator gas turbine machine, at least 36 MW is immediately feasible.

It is believed that there are six 25 MW aerocompression machines (equivalent turbine power about 60 MW) under construction, and having regard to this one may consider that free piston gas turbine electric generators of 60 MW are quite practical. They are certainly much more free from the hazards imposed by high temperatures upon the aerocompressor machines, or the combination of supercritical pressure and high steam temperature of the boilers and turbines required to deal with the initial conditions at such new plants as those at Philo and Philadelphia in the United States.

Referring to present standards and those of the immediate future, it may be of interest to examine the types of electric generating stations proposed both in Great Britain and America. Table I sets out the relevant particulars as far as they can be ascertained from published literature. It will be seen that the thermal efficiency of the simple gas turbine cycle is better than the 2,350 lb/sq in, 1,100 deg F scheme.

Factors Affecting Plant Programme

The national planning of future generating plant will be influenced by four major factors provided the present load estimates hold good. The first of these is that by 1975 nuclear plant will be used for all possible base load. Additional plant of other types will be for single-shift or two-shift operation. Secondly, from 1960 onwards nearly all future steam generating plant will be designed for high-pressure/high-temperature cycles to use the minimum amount of indigenous fuel. Thirdly, in the early stages of the plant programme up to 1975, only a portion of the total available nuclear plant will be regarded as firm system capacity, and the rest rather as experimental plant.

Lastly, in order to provide an adequate safeguard during the initial critical period of commissioning nuclear plants, it will be essential to increase coal reserves at strategic points and at principal steam stations and to import oil further to supplement home produced fuel resources. In this connection it will probably be necessary to convert further existing stations to or design new stations for oil. There can be no mistake that there is grave danger in the domestic fuel position and every available means must be employed in order to maintain the continuity of electricity supplies to British industry and essential services.

* Consulting Engineer.

TABLE I.—PERFORMANCE OF ELECTRIC POWER STATIONS

Plant	Steam Power Stations—all at 28·9 in (Hg) vacuum							Free Piston Gas Generator—Gas Turbine Stations	
	Existing		Under Construction						
Type of cycle	Straight	Straight	Straight	1-Reheat	1-Reheat	2-Reheat 1,050-1,000 deg F	2-Reheat 1,050-1,050 deg F	Straight cycle	
Pressure, p.s.i.	600	900	1,500	1,500	2,350	4,500	6,000	52	
Temperature, deg F.	850	900	1,050	1,100	1,100	1,150	1,150-1,200	900	
Boiler, klb/hr	580	550	830	860	1,400	1,500	1,800	—	
Generator, MW	60	60	100	120	200	250	325	Up to 60	
Performance Factors									
Boiler efficiency per cent	87·0	87·0	87·2	87·2	87·5	88·0	88·0	Gas generator	43·60
Turbo-generator per cent	34·4	37·0	40·2	41·6	44·3	50·6	52·2	Turbo-generator	86·00
Station auxiliaries per cent	94·5	94·0	93·6	93·6	93·0	92·5	92·2	Station auxiliaries	97·75
Steam losses per cent	98·7	98·5	98·3	98·3	97·5	97·0	97·0	Gas transmission	98·50
Realised or estimated thermal efficiency	28·0	30·0	32·5	33·5	35·0	40·0 Philo, U.S.A.	41·0 Philadelphia, U.S.A.		36·0

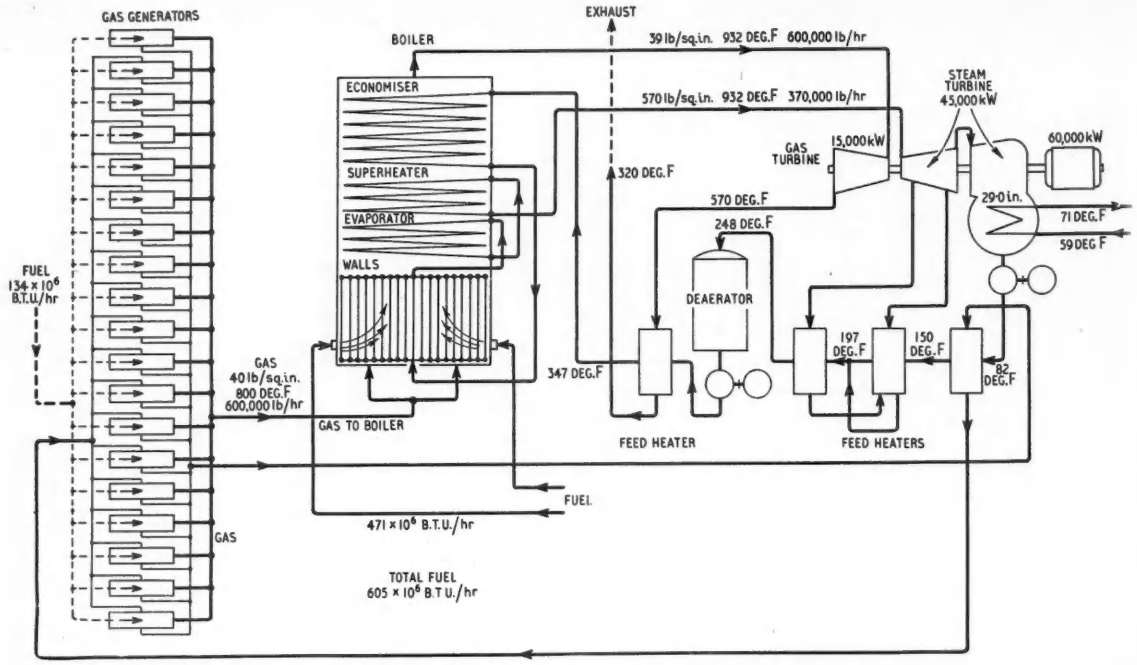


Fig. 1.—Compounding of the free piston gas turbine with a steam cycle

What then is the role of the free piston gas generator gas turbine combination in the future evolution of power generation? Before answering this question it may be desirable to state the immediate potentialities of the free piston gas generator. This is now rated at 1,000 h.p. per generator, but research and development in France, America and in this country indicate that within the near future this rating will be appreciably increased. If one considers the diesel development during the last decade and the magnitude of the progress likely to be achieved in the near future, this can provide a guide, for the nature of the problem of the free piston gas generator and the diesel are essentially similar and complementary.

Large modern two-stroke direct-coupled diesel engines can be safely run at a piston speed of at least 1,250ft/min, with a b.m.e.p. of 125-130 lb/sq in if turbo-pressure charged. As to the future, it may be safely predicted that, even for continuous heavy duty, within the next few years there will be engines available running at piston speeds of 1,800-2,000ft/min and b.m.e.p. substantially in excess of 200 lb/sq in, and possibly as high as 300 lb/sq in. Is it possible that free piston development will stand still during this period and that free piston engineers will neglect progress in other fields?

Without enumerating lines of approach, it may be inferred that free piston gas generators of 1,500-2,000 h.p. continuous rated output will be possible in the not too distant future, and that these units will be able to satisfy the most stringent demands of power station practice. At 1,500 h.p. output (1,300 kW at alternator terminals) the oscillator periodicity would be about 630 cycles/min and the generator would deliver gas at 60 lb/sq in, 1,000 deg F, conditions which in the light of projected steam stations can only be regarded as moderate.

Defining now the sphere of the free piston gas generator gas turbine machine in the field of power generation we may suggest it for auxiliary supplies to oil- or coal-fired power stations; for peak load supplies by single-shift stations with or without after-burning; as a main generating unit in two-shift stations with or without after-burning; and in combination with steam cycles, an example of which will be given and a comparison made with proposed supercritical steam stations.

Accepting that the progress indicated will be achieved and that there is no particular problem in the design of gas turbines for 60 lb/sq in, 1,000 deg F, we may look forward to standard units of 15, 30 or 60 MW normal rating with an after-burner one-hour rating one-third greater in each case. It will be seen later that according to one scheme of gas/steam compounding, the gas turbine generates about 26 per cent of the total output. The machines quoted would thus be suitable for compounding in single sets (based on normal rating of the gas turbine) of 60 MW, 120 MW and 240 MW.

When the proposed supercritical station steam temperatures are considered and note is taken of the reluctance in this country to go beyond 1,100 deg F, it would appear that the entire field of power station high-temperature metallurgy is under stringent appraisal at the present time. While conventional gas turbine practice may yield some assistance, the conditions under steam have their own special problems. In addition, the research on the development, production, manufacture, and employment of the special steels used for superheaters, reheaters, pipework, blading, etc., demands excessive effort and disproportionate cost. If these can be avoided and high intrinsic thermal efficiency still obtained, this is not only to the good of power generation, but in the national interest.

Combined Gas-Steam Cycle

While in some quarters it is believed that "the gas turbine is in its infancy and rapid change is certain," observation of aerocompression gas turbine progress shows it to be only gradual. The employment of the free piston gas generator gas turbine either on its own or in combination with steam cycles appears to represent the best technical progress.

The possibilities of simple compounding of the free piston gas turbine installation with a steam cycle are illustrated by one method shown in Fig. 1. Numerous

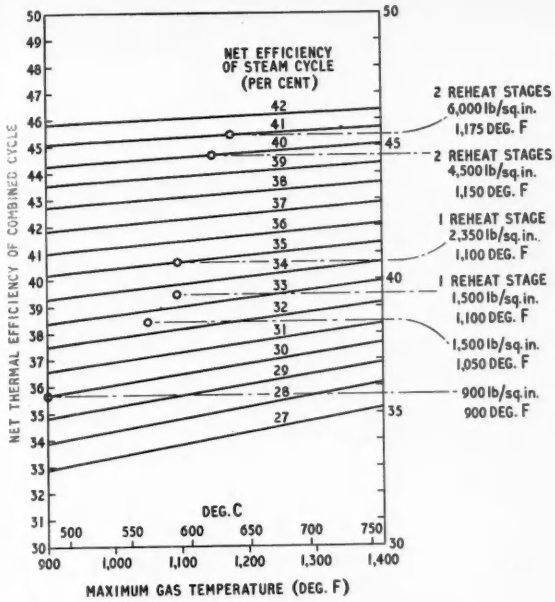

NET EFFICIENCY OF STEAM CYCLE (PER CENT)
NET THERMAL EFFICIENCY OF COMBINED CYCLE
2 REHEAT STAGES 6,000 lb/sq.in. 1,175 DEG. F
2 REHEAT STAGES 4,500 lb/sq.in. 1,150 DEG. F
1 REHEAT STAGE 2,350 lb/sq.in. 1,100 DEG. F
1 REHEAT STAGE 1,500 lb/sq.in. 1,100 DEG. F
1,500 lb/sq.in. 1,050 DEG. F
900 lb/sq.in. 900 DEG. F
DEG. C
MAXIMUM GAS TEMPERATURE (DEG. F)

Fig. 2.—Net thermal efficiency of a combined gas/steam cycle power plant relative to the maximum gas temperature on the gas turbine and steam turbine inlets

other methods of compounding are available. It will be observed that 19 gas generators supply gas to a boiler pressure type combustion chamber, where additional fuel (or after-burning) provides heat to evaporate and superheat the steam to the steam turbine. As the Sulzer mono-tube boiler is essentially suitable, this type is shown diagrammatically.

The gas turbine and steam turbine are designed for the limiting temperature of 932 deg F, which is exceptional only in the fact that this is considerably below temperatures in service or contemplated for steam cycles. The output of the gas turbine is 15 MW (equivalent to a 6 MW aerocompression gas turbine) and the output of the steam turbine is 45 MW making a total of 60 MW or four times that of the gas turbine alone. The quantity of fuel to the boiler is only 3·52 times that to the gas generators.

The efficiency of the steam cycle for only, say, 570 lb/sq in, 932 deg F at the stop valve is 28·2 per cent, while the efficiency of the gas generator cycle for about 38 lb/sq in, 925 deg F at the stop valve is 34·5 per cent from gas generator to exhaust, allowing for pressure drops in the boiler, and temperature drops from gas generators to boiler and boiler to turbine. Use might also be made of the final gas turbine exhaust as preheated combustion air to a secondary boiler. The overall efficiency of the combined cycle, making allowance for modern component efficiencies and for station auxiliaries is 33·9 per cent.

It will be noted that the gas delivery temperature from the gas generators is only 800 deg F and appreciably below that considered possible in the future, when the overall cycle efficiency will be greatly improved.

The family of efficiency curves shown in Fig. 2 indicates possibilities under advanced temperature conditions. For example, considering the conditions of supercritical stations of, say, 4,500 lb/sq in and 1,150 deg F combined with a gas turbine cycle, also at 1,150 deg F, an overall system efficiency of 44·6 per cent may be realised.

Combined Cycle Potentialities

We are now in a position to assess the potentialities of the free piston gas generator gas turbine cycle combined with the steam cycle generally in accordance with the schematic diagram in Fig. 1, which is immediately practical. It will be recalled that the combined cycle efficiency of 34·5 per cent is achieved when the limiting gas and steam temperature is 932 deg F, with due plant component efficiency corrections.

Similarly, we can now ascertain the net combined cycle efficiency and the appropriate steam cycle efficiency for other conditions. Fig. 2 shows conditions in the upper regions well in advance of any at present contemplated.

It will be observed, for example, limiting the gas temperature to only 1,100 deg F future estimated possibility, that when employing steam conditions of, say, 2,350 lb/sq in, 1,100 deg F and only one-stage reheat, combined cycle efficiency is 40·5 per cent which is even better than the overall efficiency for the 4,500 lb/sq in, 1,150 deg F two-stage reheat plant and just a little less than the 6,000 lb/sq in, 1,150-1,200 deg F plant. It will thus be evident that the extremely high supercritical pressure and the associated elevated temperatures can be

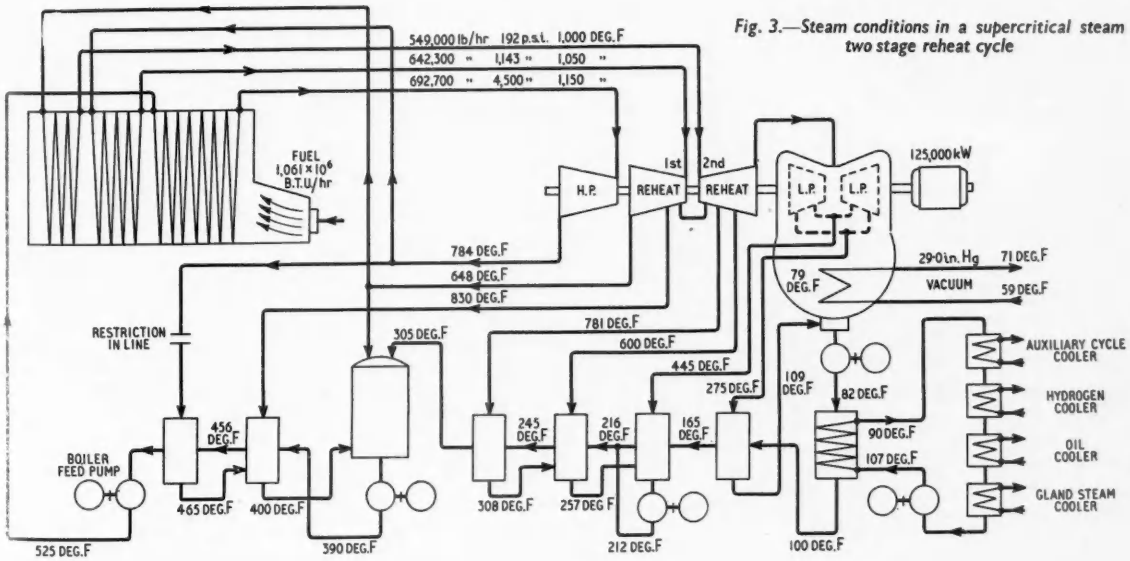


Fig. 3.—Steam conditions in a supercritical steam two stage reheat cycle

avoided by the employment of the combined gas/steam cycle.

Also, if it is considered necessary to employ the high steam conditions referred to, say, 6,000 lb/sq in, 1,150 deg F, etc., then by the combination of the steam cycle with the gas cycle an overall station thermal efficiency of 45·3 per cent can be obtained.

Using the lower conditions, the yield is lower capital cost of the station, but if the high steam conditions must be used the result is a gain of 10-11 per cent in station thermal efficiency.

If the criterion is taken as turbine blading temperature limitation, higher overall thermal efficiencies can be obtained by the combined cycle.

Fig 3 shows the steam conditions of a supercritical steam two-stage reheat cycle. The steam generator is rated at 675,000 lb/hr at 4,500 lb/sq in, 1,150 deg F. The first reheat section can raise the 655,000 lb/hr at 1,225 lb/sq in, 800 deg F to 1,050 deg F, the second 520,000 lb/hr at 185 lb/sq in from 630 deg F to 1,000 deg F. The unit has an estimated potential maximum output of 740,000 lb/hr, and the turbo-alternator 125 MW. Studies indicated that the optimum feed water temperature was about 575 deg F with the reheat pressures selected, but it has been limited to 525 deg F as shown, by the introduction of an artificial pressure drop in the steam extraction line to the highest pressure heater. For a gross generation of 127·6 MW, auxiliary power is 9,440 kW giving a net generation of 118,160 kW. The heat rate is 8,530 B.Th.U.'s per kWh or 40 per cent thermal efficiency. The station auxiliaries thus total 7·4 per cent of the gross generation. For a 6,000 lb/sq in plant they will be approximately 8·3 per cent.

For 6,000 kW free piston gas generator gas turbine installations the average percentage is 2·5 per cent, making a difference between the two supercritical installations quoted of 4·9 and 5·8 per cent respectively. This increase is an appreciable proportion of the gross output and expressed in an average national coal price to the Central Electricity Authority of, say, £4 per ton, is equal to about 4s per ton, or on oil at £7 per ton, about 7s per ton.

The auxiliary percentage for the gas turbine station includes heavy oil fuel pumping and heating, lubricating oil pumping and cooling, and forced draught cooling towers for cooling the gas generators. In this type of station the auxiliary power percentage is independent of the gas pressure to the turbine so that advances in gas generator output and pressure will have no effect upon the economy of the auxiliaries.

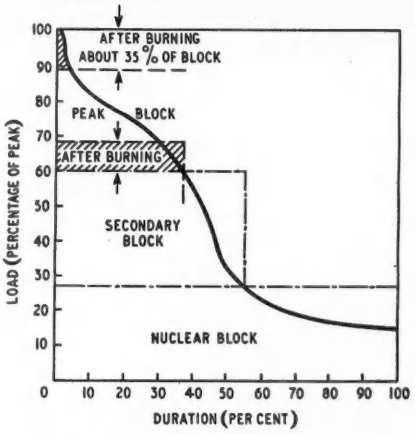


Fig. 4.—Approximate national load-duration curve with suggested allocations for different types of plant

Considering coal-fired and oil-fired steam stations on riverside sites, the average annual deterioration of performance due to fouling of the boiler heat transfer surfaces, condensers and turbine blading appears to be of the order of 2·5 per cent and 1·75 per cent respectively.

From studies of the operating conditions of free piston gas turbine stations, owing to the comparative high purity of the gas, the performance may be expected to fall by not more than 0·25 per cent, this value representing any fall in output of both the gas generator and gas turbine when using heavy oil fuel.

Total Generation Costs

It is submitted that the future choice of generation plant will be (*a*) nuclear, or, for the remainder of the load which cannot be dealt with by this form of plant, a choice between (*b*) supercritical plants, (*c*) combined gas/steam cycle with or without after-burning, or (*d*) the simple gas generator gas turbine cycle with or without after-burning.

Fig. 4 shows the portion to be dealt with by non-nuclear plants in, say, 1980, where the load factor to be dealt with is 30 per cent and the load duration about 5,000 hours per annum. It is taken that this will be the average load factor on such future plant during its two-shift, single-shift and final relegation to peak life.

Based on the convenient capacity of 100 MW Table 2 sets forth the probable total generation costs for each type of plant. Oil fuel at £7 per ton is assumed for all non-nuclear plants.

It would appear that nuclear plants cannot under any circumstances compete with modern forms of generating plant when operating at low load factors. The apparent high overall generating cost of the three types shown is only due to carrying the remainder of the low load factor system load and annual peaks.

Of these three the simple free piston gas generator gas turbine installation has marked superiority due to its relatively low capital cost and an almost equivalent thermal

TABLE 2.—COMPARISON OF FUTURE METHODS OF GENERATION

Average annual load factor 30 per cent 5,000 hours per annum for plants other than nuclear (75 per cent 8,760 hours per annum)

	Nuclear 75 per cent load factor	Supercritical 6,000 lb/sq in 1,175 deg F	Gas/steam 2,350 lb/sq in 1,125 deg F steam	Gas only
Construction cost £/kW	125	67·5	55	40
Initial fuel £/kW	25	—	—	—
Total capital cost £/kW	150	67·5	55	40
Pence per kWh sent out				
Annual charges on construction cost	0·336	0·650	0·535	0·395
Annual interest on initial fuel cost	0·036	—	—	—
Fuel cost	0·266	0·439	0·455	0·460
Works costs	0·060	0·060	0·055	0·035
Total generation cost	0·698	1·149	1·045	0·890
Credit for plutonium	0·266	—	—	—
Net generation cost	0·432	1·149	1·045	0·890
At 30 per cent load factor	1·175	1·149	1·045	0·890

efficiency to the other two. It would certainly be indicated that the closest investigation of the free piston gas generator gas turbine arrangement would be fully warranted.

Sphere of Application

In considering the allocation of free piston gas turbine plant to system requirements, Fig. 4 shows an approximate load-duration curve of the national load.

The allocation of nuclear plants is indicated and need not be discussed further. However, by raising the temperature of the gas after the gas generators by means of after-burning, the gas turbine output can be increased by 40 per cent if the final gas temperature is limited to 1,380 deg F. The turbine and alternator would be designed accordingly. Considering that some 15-17 per cent of the total C.E.A. plant operates at a thermal efficiency not exceeding 16 per cent, the simple free piston gas turbine installation with after-burning is an economical type of plant to install to meet the short duration peak as shown. Letting this value equal the approximate amount to be dealt with by after-burning, we can now ascertain the total amount of such plant to be installed for peak and single-shift operation, the balance between this block and the nuclear representing the double-shift stations. The simple gas turbine plant is of such high flexibility that sets can be got on load in 5-6 min.

The high thermal efficiency of the combined gas/steam cycle has much to commend it for two-shift operation, but as after-burning can also be used, a moderate amount is designated for dealing with system emergencies and also to assist frequency control during normal operation and load disturbances.

The free piston gas generator gas turbine plant evidently possesses characteristics of considerable importance in the future evolution of large-scale power generation.

The case presented may appear optimistic towards the free piston gas turbine installation, but suggests a critical examination of its potentialities in reference to future envisaged system operation conditions in relation to large-scale nuclear power plants.

It is believed that such an examination would not only support the conclusions drawn, but would reveal some unsuspected merits and highly desirable station operating characteristics.

The national fuel, generating plant and capital investment considerations necessitate that such an investigation should be immediately undertaken in order to define the real role of the free piston gas turbine equipment.

NEW BOOKS

Atom Harvest. By Leon Bertin. Pp. 253; illustrations 23. Secker & Warburg, 7, John Street, London, W.C.2. Price 20s.

This book, by the Scientific Correspondent of the *Daily Telegraph*, covers the "atomic" field in an explanatory, historical and biographical manner. The matter explaining the nature of the atom and the stages by which its fission has been brought to practical use, in the military and civil senses, is gently introduced in the course of a continuous account of the work of Rutherford and his brilliant successors. The importance of their work to future generations (with warnings of its dangerous possibilities) is dealt with in an easily-assimilated way.

Mr. Bertin recounts the wartime collaboration of British and American scientists and engineers and endeavours to apportion fairly the credit for their achievements. Inevitably he has to deal with the differences and difficulties which later marred this fruitful partnership but stimulated the establishment of our own atomic industry. The core of the book records the rapid growth of this industry and describes the functions of its various units. Interwoven with this are perceptive sketches of the leaders of the United Kingdom Atomic Energy Authority, bringing out their human side as well as their remarkable attainments.

To complete the story the author gives accounts of the development and testing of atomic bombs, the uses of radio-isotopes and the development of electric power from nuclear reactors. One is left wondering what the "harvest" will be.—J.H.C.

Erection of Constructional Steelwork. A Textbook for Students and Junior Site-Engineers. By Thomas Barron, A.M.I.Struct.E., A.M.Inst.W. Pp. 239; drawings 136; tables 21; photographs 26. Published for the British Constructional Steelwork Association by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 15s.

This is a thoroughly practical textbook covering every stage of operations in the erection of constructional steelwork for buildings and bridges. The book, which is a companion volume to "Constructional Steelwork Shop Practice" (also sponsored by the British Constructional Steelwork Association), deals with the preliminary surveys necessary before work can be commenced; the planning and organisation of the work on site; costing and estimating; tools and tackle, and how they are used; the types of problem which arise during actual erection, and how best to overcome them; and the techniques of riveting, welding and flame-cutting. A chapter on building regulations is also included.

By special arrangement with the British Constructional Steelwork Association, the published price of the work has been kept down to that of its companion volume, in spite of its greater number of pages and the increase in printing charges, so that it shall be well within the reach of those to whom it is primarily directed.

BOOKS RECEIVED

Garcke's Manual of Electricity Supply. Vol. 53. 1955-56 edition. Compiled under the supervision of Frederick C. Garrett. Pp. over 800. Electrical Press, Ltd., 19-20, Noel Street, London, W.1. Price £3 17s 6d.

The Economics of Electrical Installation Design. By George A. Wedge, A.M.I.E.E., F.I.E.S. Pp. 312; figs. Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 45s.

Frequency Modulation Engineering. By C. E. Tibbs and G. G. Johnstone. Pp. 435; figs. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 45s.

Electronics for Everyone. By Monroe Upton, edited by W. E. J. Farvis, B.Sc., A.M.I.E.E. Pp. 336; figs. Faber & Faber, Ltd., 24, Russell Square, London, W.C.1. Price 21s.

Introduction to Color T.V. Second Edition. By Milton Kaufman and Harry E. Thomas. Pp. 156; figs. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 25s.

Radio. Vol. III. By J. D. Tucker and D. F. Wilkinson, B.Sc., A.M.I.E.E. Pp. 249; figs. English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 12s 6d.

V.H.F. Television Tuners. By D. H. Fisher, A.M.I.E.E. Pp. 136; figs. Heywood & Co., Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 21s.

Frequency Modulation Receivers. By J. D. Jones. Pp. 114; figs. Heywood & Co., Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 17s 6d.

Modern High-Voltage Switchgear

Chairman's Address to the I.E.E. Northern Ireland Centre

THE chairman's address to the Northern Ireland Centre of the Institution of Electrical Engineers by Mr. D. S. Parry (A. Reyrolle & Co.) on 9th October was devoted to large switchgear up to 380 kV and 1,000 MVA prospective breaking capacity. So far the highest rated unit in service in Great Britain, he said, was for 275 kV and 7,500 MVA (Drakelow power station). Recently, several very large equipments had been installed indoors to facilitate maintenance especially in humid and salt-laden atmospheres. A three-cycle clearance time was normal and overall fault clearance and reclosure, including energising of trip coils and arc extinction, had recently been achieved in about 18 cycles.

The latest high-power testing station (1954) contained three low-reactance machines on frame sizes of 50 to 60 MW giving maximum single-phase output at 380 kV and three-phase short circuits up to 275 kV, maintaining substantially full recovery voltage. Voltage selection was by changing generator transformer connections, the power factor being controlled by series reactors and resistors.

In tests to ensure ability to withstand voltage surges due to faulty switching operations or electrical storms an impulse generator was used to produce high unidirectional voltage by charging capacitors in parallel and discharging them in series by means of spark gaps. The largest impulse generator in Europe was a four-million-volt 18-stage equipment made by a British transformer manufacturer.

Network analysers were almost invariably used for computing short-circuit values at various points and for voltage regulation, load distribution and synchronous stability. In one design the impedances of the power system were represented by impedances in the analyser. Another in general use was of the analogue type, such as the Blackburn, in which the impedances of network components were represented by variable-ratio transformers. Large bulk-oil or lead-tank breakers made use of arc-control devices and usually had a non-inductive resistor which was automatically placed in series with the fixed and moving contacts immediately after contact separation.

Air-blast breakers could be fitted at little cost with auto-reclosing features, which necessitated an exceptionally high speed of operation. Voltage and breaking-capacity ratings were essentially controlled by the number of air-blast turbulators. For example, a 132 kV 3,500 MVA breaker would consist of four turbulators arranged in series vertically, whereas for a 275 kV 7,500 MVA unit there would be six breakers in series connected horizontally, thus economising in overall height and giving greater rigidity of construction.

Small-oil circuit-breakers were being installed in increasing numbers, principally for outdoor service, up to 5,000 MVA at 220 kV for controlling main power station circuits and cable and overhead line distribution networks. The oil in which contact separation took place was contained in bakelised paper or otherwise physically separated from the insulating oil. This meant that insulation under permanent stress to earth (at operating voltage) was immersed in oil that was never carbonised. A fixed piston within the hollow moving contact on the downward journey injected a column of clean oil into the turbulator, thereby reducing both arcing time, particularly at low currents, and stress on the insulation. A modern small-oil breaker could be left energised, either open or closed, indefinitely.

Oil quantities for three-phase small-oil breakers bore little relationship to those required for other classes. For a 33 kV 1,500 MVA equipment they amounted to 21 gal in the circuit-breaking compartment and 69 gal for insulation and for 110 kV 2,500 MVA were 39 gal and 150 gal.

Gas Bearings for Reactor Plant

EXPERIMENTAL investigations of hydro-dynamic gas-lubricated bearings carried out at the Atomic Energy Research Establishment were described in a paper presented on 26th October before the Institution of Mechanical Engineers by Messrs. G. W. K. Ford, D. M. Harris and D. Pantall. Self-acting gas bearings improved in performance with increase of temperature owing to a corresponding increase in gas viscosity—the reverse being the case with liquid lubrication in which vaporisation or decomposition presented problems at high temperature.

An electric motor supported by two 2in diameter journal bearings had been running for some time at Harwell at 750 deg F, which would shortly be raised to 930 deg F. A pump lubricated in the same way and used for circulating oil-free carbon dioxide at 100 lb/sq in and 300 deg F through a cooling circuit in a nuclear reactor was also described; the speed of the pump, which was driven by a variable frequency alternator, might vary between 2,000 and 13,000 r.p.m.

An example of the use of a hermetically sealed pump for liquids was one in which a combination existed of poor electrical conductivity, particulate matter in suspension, high temperature and a high level of radioactivity in association with a need for long life and negligible leakage. Such conditions might make unsuitable the use of pumps of the submerged-bearing or shaft-seal rotary types and electro-magnetic or reciprocating types.

Another example was the pumping of liquid lead or bismuth at 750 deg F containing a nuclear fuel, such as uranium in solution, or a fertile material such as thorium oxide in suspension; the gas filling in this instance was of helium or argon. Nuclear radiations emitted by the liquid in the pump bowl had no effect on the gas bearings, whereas organic lubricants deteriorated in radiation fields.

Transformer Windings

THE new British Standard for paper-covered rectangular conductors, B.S. 2776: 1956, extends the range of the series dealing with covered conductors and specifies material suitable for winding medium-sized power transformers. The requirements for the conductor are based on B.S. 1432, "Copper for Electrical Purposes. Sheet and Strip," and those for the paper on B.S. 698, "Papers for Electrical Purposes." Methods of test are given, including an electric strength test on the finished conductor. It has not been possible to standardise sizes of paper-covered strip but a table of preferred sizes suitable for transformers up to 2,000 kVA is given. Copies of this Standard may be obtained from the B.S.I., 2, Park Street, London, W.1, price 5s.

CONVENTION ON FERRITES

Microwave and Carrier Frequency Applications

FOLLOWING those reported in the *Electrical Review* of 2nd November the concluding sessions of the Convention on Ferrites held at the Institution of Electrical Engineers last week were devoted to a consideration of papers on microwave apparatus and on carrier frequency applications. In one of these (A. F. Harvey) the results of the extension to higher frequencies of work already performed by ferrites were given and the applications to which these results pertained were outlined. It was shown how ferrite structures could be made to have non-reciprocal and other useful properties, and descriptions were given of the use of such structures in switches, duplexers, radiometry and cyclotron resonance detection.

The desirable properties in ferrites for microwave purposes were outlined in another paper (R. M. Godfrey, B. L. Humphreys, P. E. V. Allin and G. Mott) in which work resulting in the design of medium power isolators and circulators for 3 cm wavelengths and utilising standard nickel-zinc ferrites was described. A possible solution of the duplexing problem by using ferrites was also given.

The problems that had to be solved in developing a Faraday rotation isolator for the 6 cm wavelength regions were detailed by P. E. Ljung; and the performance data for the device were given for frequencies between 4,400 and 5,000 Mc/s. Several of the projects recently undertaken in the Radio Research Department of the Bell Research Laboratories were described by A. G. Fox. These included a study of ceramic ferroxdure at 9, 24 and 48 kMc/s, which had established that the strong absorption at the last of these frequencies was caused by a crystalline-anisotropy field of 18,000 oersteds. This material had been used as a filter, as the active element in millimetre wave field displacement isolators and as a broad-banding element in a 24 kMc/s Faraday rotator. A circulator employing ferrite-loaded coupled waveguides had also been constructed. Since full power was not applied to the ferrite this might be advantageous in high power applications.

As a result of an investigation into the effect of an axial magnetic field on the microwave properties of a magnesium-manganese ferrite in the 8 to 9 mm waveband (E. Laverick and A. Rivett-Carnac) some simple ferrite devices had been designed and their performances measured. The construction of some microwave ferrite equipments, including a resonance isolator for operation in the 3·8 to 4·2 kMc/s band, a broad-band field displacement isolator for use at 10 kMc/s and a Faraday rotation circulator and isolator for the same frequency were also described (Robieux).

Carrier Frequency Equipment

In the carrier-frequency range, which extended from audio frequencies to beyond 10 Mc/s, ferrites were used as inductor and transformer cores in those instances where advantages could, thereby, be obtained (W. F. Glover and S. E. Buckley). A wide range of magnetic properties was exhibited by these materials, since there was a considerable choice of chemical composition in their preparation. For carrier purposes, where the principal criterion was a stable inductance for tuned applications, the type most used to date was the manganese-zinc ferrite. Nickel-zinc ferrites had not been so generally employed for this range, since they possessed a higher intrinsic hysteresis loss and a higher temperature coefficient of permeability. Each of these general types could be sub-divided into many groups according to the relative amount of the different oxides they contained and even for a given nominal chemical composition the magnetic properties varied widely according to the trace impurities present and to the crystal structure. In transformer design ferrites had advantages in the frequency range above 30 kc/s. In the design of inductors for carrier frequencies either very high stability might be combined with a high or very high Q-factor, or very small units could be made to give adequate performance.

Piezo-Magnetic Filters

Ferrites for magnetic and piezo-magnetic filter elements with temperature-independent permeability and elasticity had been obtained (C. M. Van der Burgt) by using small cobalt substitutions in nickel and lithium ferrites and in mixed nickel-zinc and lithium-zinc ferrites. These cobalt substitutions, apart from leading to a very low temperature coefficient of the " real " part of the permeability, also decreased the " imaginary " part so that they had a high figure of merit.

An experimental ultrasonic viscometer incorporating a torsional ferrite transducer vibrating at about 25 kc/s had been designed (G. Bradfield) for measuring the viscosity of liquids between 1 and 100 centistokes. Ultrasonic torsional transducers, incorporating ferrites, had also been used in elasticity investigations by the dynamic method, frequencies up to 1 Mc/s being available. An application of ferrite inductors, which received mention (W. Saraga), was where high Q-values were of prime importance. The design and performance of two pairs of complementary low and high pass filters using ferrite inductors were discussed. These filters provided a discrimination of 40 decibels between the pass and stop bands. In an improved version the transition range had been reduced to 59·7 to 60·3 kc/s.

DISCUSSION

Points from the discussions on the papers presented are given below. The electronic structure of a single free atom of iron was illustrated on Monday by Professor F. Brailsford. Its 26 orbital electrons, he said, each had a spin causing both mechanical momentum and a magnetic moment.

In general, the electrons were in pairs of opposite spin with no resultant magnetic moment except in the third main shell, where the outermost sub-shell had five positive spins and only one negative. The atom as a whole, therefore, had four uncompensated positive spins and so the free iron atom had a magnetic moment of four units.

In the ferrites, the various atoms were present as ions. Removal of the two outermost electrons would give a divalent iron ion, still having a magnetic moment of four units. If a further electron was removed, the iron ion became trivalent, the magnetic sub-shell containing five electrons with positive spins and none with a negative spin, so that the trivalent ion had a magnetic moment of five units.

Similar arguments applied to divalent manganese, for example, which had a magnetic moment of five units, cobalt of three, and nickel of two.

The simple ferrites formed solid solutions one in the other; half of the " black " spheres could be one element and half another, or the proportions could be varied. Some mixed ferrites had much more useful properties than the simple ferrites.

Under the heading of magnetic spectra, Dr. K. J. Standley (Nottingham University) pointed out that a change in firing

temperature from 1,250 to 1,350 deg C halved the line width and this appeared to show that the lower firing temperatures produced more porous or less homogeneous samples.

Mr. W. D. Hepburn asked Dr. Rado whether he had related the size of the domains in his ferrites to the crystal size. If the domain and crystal sizes were of the same value, it might be difficult to move the domain walls, which would presumably occur at the crystal boundaries.

Dr. Rado agreed that if the crystals were very small there was a fairly good chance that the domain wall would be highly immobile.

Regarding molecular interaction (30th October) Dr. T. E. Allibone said that the comparatively new technique of neutron diffraction would be useful in determining the location of ions in a ferrite lattice and in the investigation of magnetic materials. The study of magnetic exchange mechanisms should lead to a better understanding of existing ferrites and provide a sound basis for the development of new ones.

Dr. J. P. Goodenough referred to the concept of covalence as a second approximation to the ionic-crystal model, which as regards ferrites could give only an incomplete picture of such properties as ionic ordering, crystalline anisotropy and crystalline distortions and could tell nothing about magnetic exchange interactions and magneto-striction. Far more experimental investigation was, however, still required.

Dr. E. M. Gorter, referring to the discrepancy in saturation values as between different laboratories, stressed that small deviations from the correct oxygen content of Fe_2O_4 could make considerable differences in saturation moments.

Mr. M. Williams questioned whether deductions from anisotropic measurements and permeability were thoroughly reliable. The d.c. measured value, he said, was markedly dependent on the frequency. If grain boundaries were largely responsible for resistivity, what was measured seemed to be not the resistivity of the ferrites but a complex phenomenon of ferrite values and grain boundaries.

Mr. L. Lewin asked whether the explanation of the phenomenon might not lie in heterogeneous material.

Dr. L. C. F. Blackman said that while the d.c. resistivity of ferrites might be the same in individual cases the density was completely different. There would appear to be some significance in the falling-off of resistivity.

Mr. M. Williams suggested that variations of density with firing temperature would not necessarily change the d.c. resistivity. Some materials with lower resistance at higher cycles had higher resistance at higher frequency.

Radio and Television Applications

In the Session D, allocated to radio and television applications, Mr. L. A. Thomas questioned whether it was worth while to cut down the comparatively small losses in the magnetic core. With regard to ferrite rod aerials, apart from their small size their value depended on their directional properties. He wondered to what extent the continental practice of building a rod aerial into the set which could be moved in the set rather than moving a portable set to get the best signal would be followed up. With regard to powder metallurgy, he thought dust cores were easier to fabricate and maintain to close dimensional tolerances than ferrites.

Dr. H. M. Schlicke said that a television set might cease working after a time on account of rise of temperature. Losses increased with temperature and the flooding became warmer and warmer.

Mr R. Ritchie held that ferrites needed very much reduced temperature coefficients in their practical application, especially in aircraft. Their values should not vary so considerably if the ferrites were truly homogeneous.

Mr. W. Saraga pointed out that ferrite rod aerials, first introduced to limit interference, were now used in inappropriate applications. An original assumption was that a large amount of gain was available, but they were now used in transistorised portable receivers. The smaller signal strength must surely counterbalance other advantages.

Mr. E. C. Shelling asked whether the change in properties due to mechanical vibration was peculiar to nickel-zinc ferrites. He had not noticed it with the manganese type.

Mr. R. Bailey said he had a possible application for a hard magnetic material at 300 Mc/s. Was there any possibility of such a material being developed?

Mr. G. Avis pointed out that when measuring temperature coefficient the d.c. primary current must be stable. Otherwise, it would slide up and down and mask the temperature that was being measured.

New Materials

In the discussion on new materials, Dr. A. J. E. Welch (Imperial College), referred to lead ferrites in which hexagonal structures existed over wide composition ranges. In addition to plumbo-ferrite, some of them contained smaller proportions of iron oxide, possibly structurally related to the new materials which Jonker, Wijn and Braun had introduced.

Mr. A. C. Lynch (P.O. Research Station) remarked on the great difficulty of making the same mixed oxide twice. The introduction of X-ray diffraction methods made it possible in the early 1930s to differentiate between cubic and hexagonal structures. Cubic rather than hexagonal materials had been chosen by Dr. Snoek because the anisotropies were likely to be much smaller in a cubic system, so that the chance of finding high permeability would be greater. That judgment had been confirmed, but by going to hexagonal structures another large range of materials had been found which would be useful in a range of frequencies which was becoming of increasing interest.

Mr. J. H. Bruce (Radar Research Establishment) emphasised the importance of problems of loss, of rotation, and of saturation. With the hexagonal ferrites there was extreme anisotropy not only magnetically but electrically, which might affect their dielectric properties. Would the very high dielectric losses at low frequencies with ordinary ferrites also be found with hexagonal ferrites?

Mr. J. H. Richards questioned the practical importance of the new materials described and wondered whether their Curie temperatures would turn out to be above or below room temperature. Jonker, Wijn and Braun had maintained a permeability of about 10 to a frequency nearer to 1000 Mc/s than to the 100 Mc/s obtainable with nickel-zinc, but at present this frequency range was of less interest than the lower frequencies, and it would be of more interest to have a material with higher permeability even if the frequency limit were 100 Mc/s or less.

Dr. K. Hoselitz asked whether it would be possible, with Dr. Gorter's Y ferrites, either by prolonged heat treatment or by quenching from suitable temperatures, to get ordering of the various ions on tetrahedral sites. If so greater values of saturation could be achieved.

Dr. O. W. Simpson asked whether with mixed ferrites of Dr. Wijn's type the anisotropy in the basal plane could be reduced to give higher permeabilities.

M. F. Bertaut referred to the expense of the new materials. As they had been born only at Christmas, 1955, some of their properties were not yet known. The Curie point was about 600 to 650 deg C.

Dr. Wijn agreed on the difficulty of making a second mixed oxide identical with the first, but said it was no more difficult to make MgY than magnesium spinel. With a hexagonal structure there were always stresses due to cooling, and these and magnetostriction would give low permeability.

Mr. G. H. Perry, speaking on square-loop applications, suggested the possibility of a cell type of construction in general digital circuits. By using modern h.f. junction transistors in conjunction with the higher output voltages, and lower m.m.f. required by a magnetic store in the form of a cell, could be operated digital circuits using single turns. Thus the 100 turns of 47 gauge wire on a 2 mm core could be replaced by three pieces of 37 gauge wire passed through a block of ferrite.

Mr. R. H. A. Carter expressed the view that the usual simple transformer theory could not be applied to square-loop ferrites. The rate of change of flux in the core did not follow the applied current waveform but was dependent upon the net value of H, taking into account the instantaneous value of both the primary and secondary currents and the characteristics of the core material.

When switching cores from one step to the other, the

applied current usually had a rate of rise so far in excess of the maximum rate of change of flux in the core that the former might be considered as instantaneous. Therefore the rate of change of flux in the core was dependent upon the secondary current, with an inverse law. Hence the voltage developed across the secondary winding was a direct function of the load impedance, tending to keep the secondary current constant.

Mr. B. D. Simmons agreed with Mr. Willis that saturable transformers using square loop ferrites were not immediately suitable for track selection in the "read operation," yet to be able to use the same selection apparatus for both "read" and "write" operations was economically desirable compared with separate matrix selection of a common head for reading and writing. Strip-wound cores of initial high permeability nickel-iron alloy used as saturable transformers could provide discriminatory gating of read and write signals. With a balanced two-core arrangement, the resultant transient break-through when switching cores was insufficient to disturb the magnetic state of the track under affected heads. Switching was substantially complete in 20 μsec using control currents of 100 mA. The system had found particular application in an all transistor scheme where lower powers and better impedance matching were at present necessary.

Anisotropy and Magnetisation

Mr. G. O. Whittington (Marconi's) mentioned that the replacement of these ferrites by ionised gases showed that there was a close mathematical analogy to magneto-ionic theory, in which the ionised medium became anisotropic only when a magnetic field was present, but he was not clear whether that applied to the ferrite.

Mr. P. J. B. Clarricoats replied that the anisotropy of a ferrite did depend on magnetisation. In terms of the tensor permeability it could be said that when the magnetic field was removed the off-diagonal components of the tensor would vanish. That was the theoretical picture; but, of course, internal fields did exist within ferrites, so that anisotropy of an individual particle might still arise at certain frequencies in the absence of an applied magnetic field.

Professor H. E. M. Barlow submitted that accurate and reliable measurements of new materials often provided the key to the really important advances in their application. Analytical and experimental work should go forward hand in hand, but as engineers most of them put particular emphasis on the experimental work.

In investigating the high frequency behaviour of ferrites they had established some exceedingly valuable practical applications. Isolators, modulators and switches, all depending upon the properties of ferrites, had opened up a vast new field of application.

Mr. P. F. Mariner (Elliott Bros. (London)) suggested that during the present experimental period work on ferrites had been of a comparatively qualitative kind, but it would soon be necessary to compare the results obtained all over the world.

Mr. Fox said that what one saw depended very much on the geometry. For certain geometries it was necessary to go to very high power levels before they could be seen, while for very unfavourable geometries they might appear at power levels of 1 to 3 kW. In general, if the ferrite was excited by the negatively-polarised field there was apparently no appreciable non-linear effect to be observed.

Mr. P. J. B. Clarricoats (G.E.C.) said that the energy concentrated in an unbounded dielectric rod depended very largely on the refractive index and only slightly on the wave impedance. It was qualitatively possible to extend this to the case of magnetised ferrite as regards changes of permeability and refractive index. For the dielectric rod in the circular waveguide they had obtained a cut-off condition, the value of the rod radius to the free space wavelength, at which various high-order modes could propagate. They had obtained analytical expressions for the slope at cut-off and for the value of the ratio of rod radius to free space wavelength at which the guide wavelength was equal to the free space wavelength.

Mr. P. P. Eckersley (Telephone Manufacturing Co.) opened the discussion on carrier frequency applications by inquiring about the possibility of producing a single modulation system with filters suitable for direct modulation at frequencies of 60 to 108 kc/s.

Mr. L. I. Farren (G.E.C.) said that one important application of filter coils was the 12-channel open-wire system. This involved a pair of wires carrying two different frequency bands of signals in opposite directions. At a repeater station there were filters which divided the l.f. and h.f. bands meeting at a pair of terminals where there was a very high level of signal in one direction and a very low level of return signal. If the high-level signals caused intermodulation in the coils adjacent to the terminals they might generate frequencies in the low-level band. Two disturbing signals must not create a sum or difference product more than 100 dB below the actual values of the signals. The practice had been for many years to use air-cored coils.

Mr. T. R. Scott (Standard Telephones) considered that the impact of ferrites on the carrier field seemed to lie not mainly in what they would do when these prospects became realities. In the carrier range there were now obvious signs of time division methods coming in, and a great deal of work was being done in introducing ferrites there.

Mr. J. M. Herbert (Plessey Co.) said that one troublesome factor in ferro-electrics was the variation of their properties with time.

Mr. W. Saraga (Telephone Manufacturing Co.), referring to the ferrite material used for inductors, mentioned various effects which, taken together, might cause a marked difference between the published temperature coefficient of the material and the temperature coefficient of the complete inductor.

Mr. J. J. Thompson expressed interest in the development of longitudinal adhesive strain-gauges of the ferrite type and their response characteristics with regard to frequency and sensitivity.

Mr. W. F. Glover, replying to Mr. Eckersley's question about the use of ferrites to provide filters for a single modulation system, said that while there had been developments on those lines they had not reached a stage when they were likely to displace crystal filters. Quartz was a nice stable material.

Mr. G. Bradfield said that the performance of ferrite materials under pulse conditions was fairly satisfactory. For strain gauges, if the ferrite were polarised and then used at a low rate of change of strain there would not be enough inductance to be satisfactory. With the new cobalt type of ferrite the results without polarisation might be more useful.

Oil Trends in Europe

IN a report entitled "Oil—the Outlook for Europe" a committee of the Organisation for European Economic Co-operation (2, Rue André-Pascal, Paris 16) analyses the present position of the oil industry in Western Europe as a whole and in individual countries and forecasts requirements over the next twenty years with more detailed treatment of 1960. The report is, in some respects, supplementary to the Commission's publication "Europe's Growing Needs of Energy" (*Electrical Review*, 8th June, 1956).

Oil consumption in Western Europe rose from 37 million tons in 1947 to 100 million tons in 1955, while crude-oil throughput of refineries rose from less than 20 million to over 100 million tons.

Total consumption in 1960 is estimated to be more than half as much again as in 1955 and to be doubled between 1960 and 1975. The pattern of demand is expected to change significantly owing to increasing substitution of oil for solid fuels. Indigenous crude-oil and natural gas will probably make a growing, though modest, contribution, but world reserves are considered likely to be ample for the next twenty years.

Fuel oil prices are not expected to rise above those current in the Caribbean area as long as it continues to supply a major part of world needs. World capital investments over the next ten years are put at $115,000 million, including $41,000 million outside the U.S.A.

Power Reactors

Graphite-Moderated Gas-Cooled Type

IN a lecture to the Institute of Fuel on nuclear reactors for power production, on 31st October, Mr. F. M. Greenlees (United Kingdom Atomic Energy Authority) said it would be a great mistake to believe that the conservatively designed reactors of the graphite-moderated, gas-cooled type at present in use had only a limited future.

There was no known way of converting nuclear energy into power without going through the heat cycle, and the heat of the reactor must be released at the highest possible temperature. The reason why the fission process could not at present be operated at a very high temperature was not nuclear-physical but engineering and metallurgical.

The active core of the graphite-moderated, gas-cooled, natural uranium reactor was likely to be at least 30ft in diameter, with a specific rating of 1 to 2 MW/ton with gas coolant under pressure of at least 100 lb/sq in. Such a reactor might hold about 110 tons of fuel and yield 750 million B.Th.U./hr at 660 deg F, or perhaps 45 MW.

From a physicist's point of view, heavy water was the best moderator for a thermal reactor since it gave the best neutron economy known. The critical size of the core might be 10 to 12ft, and gas coolants could not get the heat away from the smaller surface area but liquid metals could be used. The great disadvantage was the limited availability and high cost of heavy water; but the possibility of its coming to the forefront should not be excluded. This type of reactor would hold 10 to 12 tons of fuel with a rating of 5 MW/ton giving 250 million B.Th.U./hr at 525 deg F, or 15 MW of electric power.

Ordinary or "light" water might be employed as both moderator and coolant, provided the uranium was enriched to 20 per cent above the normal concentration of U235. This reactor core might hold 50 tons of fuel with a heat rating of 5 to 10 MW/ton and produce 1,000 million B.Th.U./hr at 525 deg F, or about 60 MW. Its capital cost was the lowest of any type so far envisaged.

The graphite-moderated liquid-metal-cooled reactor could have heat ratings of 5 to 20 MW/ton, owing to the higher heat transfer obtainable by the use of such coolants. The reactor core would probably be 25ft in diameter and hold 100 tons of fuel. At a rating of 5 MW/ton, 1,700 B.Th.U./hr might be extracted at about 900 deg F, or about 100 MW.

In the fast reactor the moderator was dispensed with and costly highly enriched fuel was used. Its core would possibly be a cylinder 2ft in diameter and length with a heat rating of perhaps 100 MW. Fast reactors could be made to breed more fissile material than they consumed and also produce plutonium as a by-product. Possibilities were heat fluxes around 3 million B.Th.U./hr/sq ft. The small core might hold 2,000 lb of enriched fuel and 200 million B.Th.U./hr might be extracted at temperatures up to 950 deg F, or 15 MW from the minimum size of reactor.

Another fast fission reactor was the homogeneous type, in which the fissile material was in solution or suspension, possibly in water, thus turning the reactor into a tank. Such a reactor might be rated at 15 to 20 MW/ton of basic fuel, and might be expected to extract 50 to 70 million B.Th.U./hr per ton of fuel in the cycle at temperatures only limited by metallurgical considerations, possibly around 950 deg F in the first instance. The electrical power obtained from such a reactor would vary with the tonnage of fuel in use, but a reasonable estimate would be 60 MW with about 10 tons of fuel in the cycle.

European Free Trade Area

IN a letter to the President of the Board of Trade the Federation of British Industries has given a summary of the results of an inquiry it has made among members for their views on the proposal that Great Britain should combine with six European countries to establish a limited free trade area (see *Electrical Review*, 19th October, p. 707).

The Federation first expresses its members' dissatisfaction at the limited time given for consideration of the subject and also refers to the lack of definition in the terms of the proposal.

It is said that "entry to a limited free trade area over a period of 12-15 years would be supported or even welcomed by many branches of industry if they were satisfied that safeguards could be negotiated, while it would be strongly opposed if they were not satisfied." Many industries fear that competition on equal terms would not be realised in the event. An offer is made, however, to establish consultative machinery if the Board of Trade concurs.

Some of the affiliated trade associations were not willing to express their views; of those who have not all are in favour. An appendix to the letter tabulates the broad views of about 140 associations. Among those supporting the idea of negotiations, provided safeguards are worked out, are the British Electrical and Allied Manufacturers' Association, the British Internal Combustion Engine Manufacturers' Association, the Scientific Instrument Manufacturers' Association, the British Refrigeration Association, the British Industrial Measuring and Control Apparatus Manufacturers' Association, the Radio and Electronic Component Manufacturers' Association, the Electric Lamp Manufacturers' Association, and the British Plastics Federation. The Telecommunication Engineering and Manufacturing Association does not oppose further negotiations assuming that safeguards are worked out.

The list of those who are opposed to negotiations unless certain safeguards are assured includes the Cable Makers' Association, the Covered Conductors Association and the Radio Communication and Electronic Engineering Association.

The British Engineers' Association, the Water Tube Boilermakers' Association, the British Radio Valve Manufacturers' Association and the Mechanical Handling Engineers' Association have been unable to reach decisions in the time available while the Radio Industry Council and the British Radio Equipment Manufacturers' Association "have found opinions too divided to be able to give a collective view."

The desired safeguards relate to such matters as Imperial preference, dumping and unfair trade practices, exchange and currency problems, taxation, labour costs, export agreements and strategic industries. Those opposed to negotiations fear flooding of the home market with no compensatory advantages in freer entry to European markets and think that certain natural advantages enjoyed by European countries cannot be overtaken by improvements in efficiency. They also doubt whether "watertight" safeguards could be worked out to ensure competition on level terms.

GENERATION AND DEVELOPMENT

Skelton Grange Power Station Extension

The Central Electricity Authority has received the consent of the Minister of Fuel and Power to an extension of Skelton Grange "B" power station, Leeds, which will increase its total installed capacity to 480,000 kW instead of 360,000 kW originally planned. The consent covers the installation of one 120,000 kW turbo-generator set and one 860,000 lb/hr boiler. The Minister has also given approval to the substitution of three 120,000 kW sets instead of six 60,000 kW sets which were to have been installed in this station.

Manweb's Rural Programme

Last week the Merseyside and North Wales Electricity Consultative Committee, in conjunction with the County Councils concerned, convened special meetings at Caernarvon, Llangefni, Newtown and Dolgelley to afford the Board an opportunity of reporting on the progress already made on rural electrification and to forecast future prospects in this field; and to enable the representatives attending to ask questions. The audience at each meeting was given an outline of the rural development plans and a booklet was distributed showing the expansion which has taken place during the last eight years. The meetings created keen interest in each county, and there were capacity attendances on each occasion.

Mr. D. H. Kendon, chairman of the Board, said that the Board's rural electrification programme was the largest ever tackled in this country, and to date more farms and other rural premises had been connected than in any other area. The programme would take until 1968 to complete. In the last eight years the Board's capital expenditure in North Wales and parts of Cheshire and Shropshire exceeded £10 million, of which nearly £4 million had been spent on rural electrification and £2½ million on reinforcement work. The increase in the use of electricity in North Wales was running at the rate of about 20 per cent per annum. The Board did not receive a grant for rural electrification as was often supposed, but financed the expenditure out of its own revenue. In the eight years under review the mileage of mains in commission in the rural development area had been doubled by the addition of over 3,000 miles of mains. Transforming stations had increased in number from 1,300 to over 7,000 and nearly 80,000 new consumers had been added, including nearly 8,000 farms.

After the severe restrictions on capital investment imposed in 1951 had been released, Manweb's rural development programme had been geared up to a new record pitch when once again the country was faced with grave economic difficulties. Restrictions on capital investment were again imposed and the electricity supply industry had to take its share of the cuts. The Board had, however, rearranged its capital programme so that planned expenditure on rural projects had only to bear the same rate of reduction as expenditure on reinforcement and other important works.

Mr. Kendon stressed that the problems of alternate acceleration and deceleration of progress within comparatively short periods of time were acute. New staff had to be recruited and trained and then became redundant and in many cases completely lost to the industry. The maintenance of zeal and morale in the field became difficult and long-term plans for the purchase of plant at advantageous prices had to be abandoned.

New Hydro-Electric Stations

The North of Scotland Hydro-Electric Board has brought into commission the Ceannacroc hydro-electric power station in upper Glen Moriston, Inverness-shire, and the Kilmelfort hydro-electric power station in Argyll.

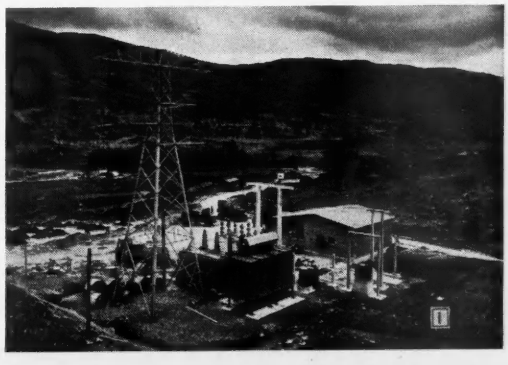
Ceannacroc is the first station of the Board's Moriston scheme to come into production. It is built underground and has a main turbo-alternator of 16,000 kW and a 4,000 kW set for maintaining the minimum flow of the river below the station. The turbines, operating under a gross head of 296ft, will have a total average annual output of 70 million kWh.

The Board's works in the upper part of Glen Moriston consist of a dam at Loch Loyne from which the water passes through a tunnel to Loch Cluanie which has been enlarged by a dam at its eastern end. Water is brought from Loch Cluanie by a 2½ mile long tunnel to Ceannacroc power station and is discharged by a tailrace tunnel into the River Moriston near Ceannacroc Bridge.

The Kilmelfort station has a capacity of 2,000 kW and is situated on the River Oude near the Pass of Melfort. The main storage of the scheme is provided in Loch Tralaig which has been raised by a low dam. After passing through a small turbine, the water discharged from Loch Tralaig feeds a new loch or headpond formed by a dam at the top of the pass alongside the Ardrishaig-Oban road. From this loch, the water passes by tunnel and pipeline to the power station. There

Ceannacroc generating station, Glen Moriston

1. View of transformer compound. 2. Bottom of shaft showing control gate and screens. 3. Spiral casing of 16 MW machine entering access tunnel for erection in the underground station



is also a small dam and diversion works at Loch na Sreinge to bring in water from an adjacent catchment.

The civil engineering consultants for the Moriston scheme are Sir William Halcrow & Partners and the electrical and mechanical consultants Messrs. Kennedy & Donkin. For the works in upper Glen Moriston the main civil engineering contractors are the Mitchell Construction Co., Ltd. The main turbo-alternator was manufactured for the English Electric Co., Ltd., by Harland & Wolff, Ltd., at Scotstoun and the smaller machine was made by the Harland Engineering Co., Ltd. Mr. Robert Hurd, B.A., was responsible for the architectural features.

For the Kilmelfort scheme the civil engineering consultants are Messrs. Kyle & Frew and the electrical and mechanical consultants Messrs. Strain & Robertson, the main civil engineering contractors being R. J. McLeod (Contractors), Ltd. The turbine was manufactured by Gilbert, Gilkes & Gordon, Ltd., and the generator by Bruce Peebles & Co., Ltd. The architect for the power station and other features was Mr. Ian Lindsay, B.A.

The Board also started up recently a diesel generating set of 2,040 kW at Lerwick, which brings the present capacity of this station to 6,240 kW. The diesel set was made by Mirrlees, Bickerton & Day, Ltd., and the alternator by Bruce Peebles & Co., Ltd.

Football Ground Floodlighting

When Norwich City played Sunderland recently the new floodlights at the Carrow Road ground, Norwich, were in use for the first time. Installed by the Eastern Electricity Board with Boulton & Paul, Ltd., as the subcontractors for the steel towers, and the Revo Electric Co., Ltd., for the floodlighting units.

The lights are mounted on pylons and each tower is arranged to carry a maximum of 20 floods. Focusing has been arranged so that each of the sixteen equal rectangles into which the field has been divided receives one quarter of its light from all four towers. The total loading is about 100 kW. The Board, in order to provide the football club with this load, had to erect a new substation. The switching of the lights is such that either one-third, one-half, or two-thirds can be on as required. For the lighting of the stands, terraces, car parks, exits and entrances about three miles of cables and 150 lighting points are used. A stand-by diesel driven generator has been installed.

Economics of Water Power Schemes

The Executive Committee of the Scottish Landowners' Federation, at a meeting in Edinburgh on 24th October, decided to ask Parliament to consider the re-examination of hydro-electric development in Scotland. It was stated that the costs had risen enormously, and the Committee was not satisfied, without an impartial re-examination of the whole question, that all contemplated schemes could be justified.

A spokesman for the North of Scotland Hydro-Electric Board afterwards stated that the hydro-electric schemes were making a worthwhile contribution to the country's sources of fuel, they provided employment, and the electricity produced was raising standards of living, helping agriculture, and encouraging the setting-up of small new industries in the Highlands. The Board was now supplying 347,000 consumers, most of whom would never have had a supply but for these hydro-electric schemes. Some 10,400 farms in the Board's area now had an electricity supply, whereas in 1948 there were only 1,400; in addition, there were now about 12,000 crofts connected to the mains. The merits of every hydro-electric scheme had to be examined by the Secretary of State for Scotland and his advisers before being presented to Parliament.

New Y.E.B. Primary Substation

The Mayor of Pudsey (Councillor F. West) recently opened the new Rodley supply point and control centre of the Yorkshire Electricity Board, which will supply the eastern half of the Bradford Sub-Area and the western fringe of the Leeds Sub-Area. The load in the zone supplied from Rodley increased from about 48,000 kW in 1948-49 to 74,000 kW in 1955-56.

Colliery Power Station

Now well advanced, the Bowhill Colliery power station of the National Coal Board, Scottish Division, should be put into commission this year and will burn 48,000 tons of slurry per annum. This material contains 30 per cent moisture and 20 per cent ash. It is now N.C.B. policy to burn slurry wherever possible and some 20 slurry-consuming plants are projected for use by the Board throughout the country. The Bowhill scheme is part of a major development of mining activity in West Fife.

OVERSEAS

Conflicting Nigerian Forecasts

The latest report of the Electricity Corporation of Nigeria, covering the year ended 31st March, 1955, discloses differences of opinion between itself and its advisers on the trend of development over the ensuing years. An International Bank mission, in a report on the country's economic development, anticipated an average increase of 16·5 per cent in demand over the period 1954-60 and the mission considered that the Corporation would require £6·97 million capital. Mr. A. G. F. Farquhar, of the United Kingdom Ministry of Fuel and Power, who went to Nigeria in 1954, and made 20 specific recommendations, 14 of which have already been adopted, indicated that an annual load growth of something over 7 per cent was a good working hypothesis, with the reservation that in the early years of a new development it might have to be used with caution.

The Corporation, however, maintains that Nigeria's demands will entail a rate of growth exceeding 20 per cent and its report points out that the actual increase in electricity generated and purchased in 1954-55 was 23·6 per cent as compared with its own forecast of 23·2 per cent. For the period 1955-60 its capital requirements are put at £10·8 million, a figure which it feels may well prove inadequate in view of the trend of rising prices.

In 1954-55 the Corporation generated 131·6 million kWh and purchased 7·9 million kWh. Sales totalled 110·7 million kWh, an increase of 23·1 per cent. The report says that, apart from finding the capital required, the work of coping with the expected demand presents almost insuperable difficulties owing to the continuing shortage of qualified staff. There is unlimited scope for private enterprise to undertake the necessary contracting work provided the capital needed can be found.

The total income of the undertakings during the year was £1,577,656, and after allowing for a Federal Government subsidy of £30,000 there was an operating surplus of £236,096. The cost of administrative, technical, supervisory and other services and provision for depreciation amounted to £415,770, resulting in a net loss of £179,674. No charges have been made against the undertakings in respect of interest on capital.

Loan for Laxapana Scheme

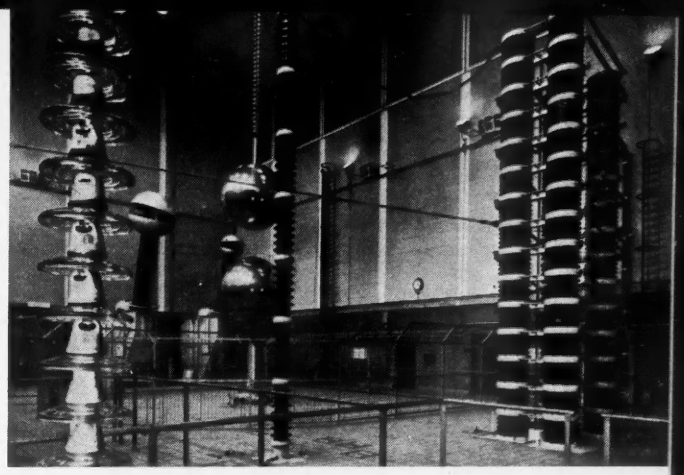
The Finance Minister of Ceylon, Mr. Stanley de Zoysa, who went to Washington for the annual meeting of the World Bank, said recently that he had made a formal application for a further loan from the Bank to finance the foreign exchange costs of the second stage of the hydro-electric scheme. Preliminary talks had proceeded favourably and the prospects of obtaining the loan were very good.

It is expected that a technical mission from the World Bank will visit Ceylon shortly to discuss details.

Large Thermal Station for Sweden

The total capacity of Sweden's power stations is at present 6,000 MW, of which 4,800 MW is derived from water power. By the middle of the 1960s, however, the largest power station in Sweden will be thermal. This station, like several other industrial installations, will be built into solid rock. It will have an initial output of 600 MW which may be increased to 900 MW. By comparison, the largest power station at present in operation, Harspranget, has a capacity of 350 MW.

HIGH-VOLTAGE GLASS INSULATORS

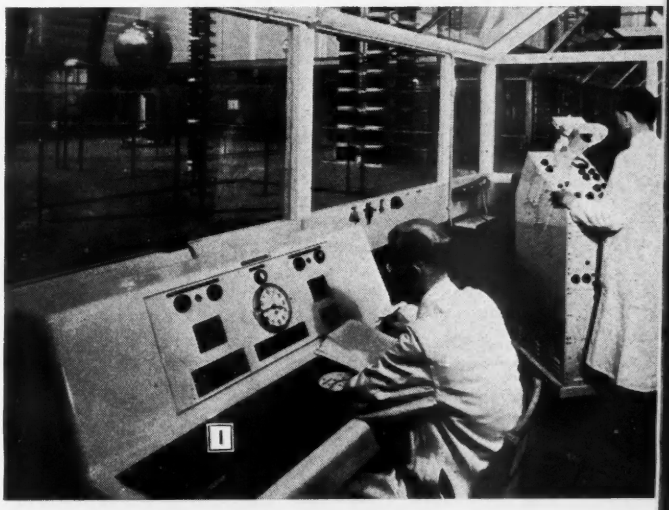


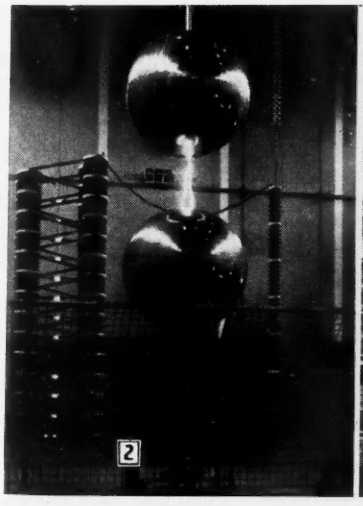
New Research and Testing Laboratory for Pilkington Brothers

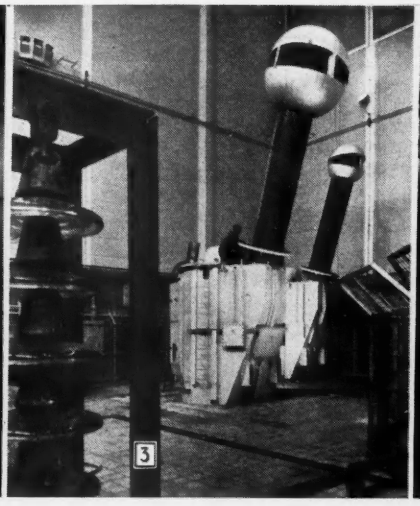
1. Impulse generator control room showing control desk and oscillograph. 2. The standard of measurement for voltage is a two-metre diameter sphere gap arranged vertically. 3. Two 650 kV power frequency testing transformers in course of erection. 4. For mechanical strength tests a 50-ton hydraulically operated Avery tensile testing machine is used

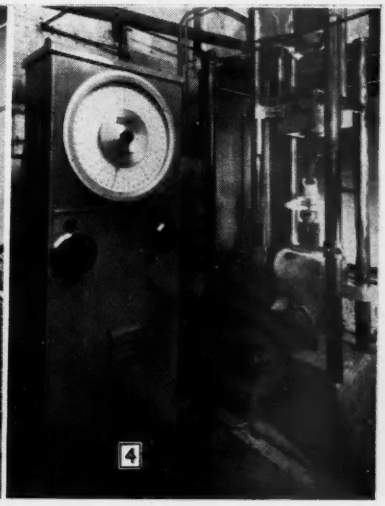
THE new £200,000 high-voltage insulator laboratory of Pilkington Brothers at Ravenhead, St. Helens, Lancs, was opened on 2nd November by Lord Citrine, chairman of the Central Electricity Authority, who as a young man was employed for a time in the St. Helens glass industry. This laboratory has three main functions which are accorded equal importance by the management. These are, first, research with a view to improving the performance of toughened glass insulators and strings. Secondly, to give the fullest possible service to customers and ensure that the insulator string arrangements offered will meet their specifications. Thirdly, to carry out electrical and mechanical tests in accordance with British Standard 137, or the national test specifications of customer countries, or the international specification for glass insulators, expected to be issued shortly. The new laboratory is primarily a measuring tool.

The project was designed by Mr. E. F. Johnston and the staff of Pilkington Brothers in consultation with the Metropolitan-Vickers Electrical Co., Ltd., which supplied the main electrical installation. The building was designed by Mr. C. C. Handisyde and built by Bovis, Ltd. The main building is a large hall, 120ft by 80ft by 60ft high, which has been designed for the maximum possible clearance if, as is likely in the future, the scale of testing should be increased. The major clearances were for the impulse test machine, a sphere of 25ft radius at a height of 33ft; for power frequency tests, a sphere of 30ft radius at a height of 41ft; for the sphere gap, a sphere of 28ft at a height of 30ft; and also for various test objects at a height of about 25ft. The dimensions in fact are determined by the clearances to earth which must obtain when working with very high voltages. Most of the floor space is devoted to high-voltage testing, but isolated from the testing areas by a high metal safety fence with interlocking devices is









a perimeter passage in which the mechanical testing plant is installed.

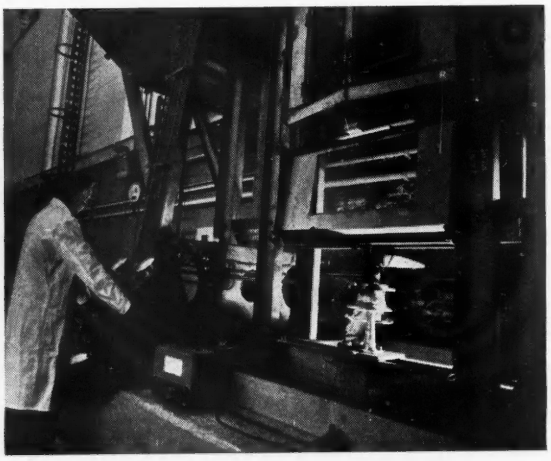
In annexes around the laboratory are provided a dark room, a substation and storage spaces. A two-storey office block provides an entrance. On the second floor a sound-proof conference room overlooks the test area through a large observation window high in the wall of the main laboratory.

Natural light is admitted through 2,500 sq ft of vertical glazing high up in the side walls. Although good natural light is required over the whole of the test area floor, and also good upward vision towards the suspended test objects, certain testing, such as corona observation, has to be carried out in complete darkness. The total blackout is achieved by means of electrically operated blinds over the clerestory glazing, which is controlled from the floor and permits the building to be thrown into darkness in 15 sec. The doors are weather-stripped to prevent light leakages. The main artificial lighting is from high-power downward reflectors recessed into the ceiling. To counteract the glare from these, wall-mounted lights are arranged to project upwards, illuminating the ceiling itself.

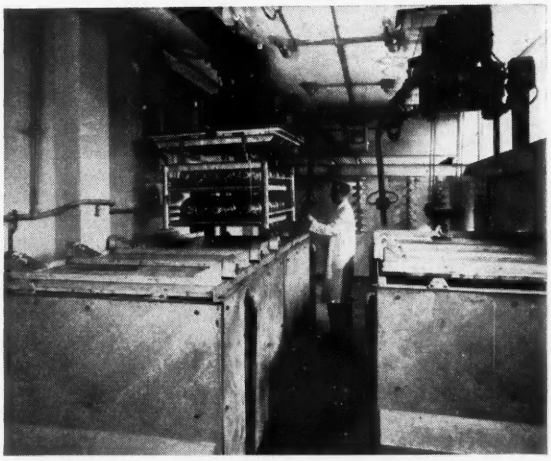
Because the main test space is very large and some of the apparatus at high level has to be kept dry, despite the use at times of "rain" sprays as part of the testing procedure, the heating requirements are unusual. Consequently, high-temperature radiant heat provided by gas radiant heaters hung from the walls at two levels has been chosen as the most economical method, and the result appears to be satisfactory.

The electrical testing equipment is elaborate. High-voltage tests may be carried out with either impulse or power frequency voltages, on both vertical and horizontal strings of insulators. Vertical strings are suspended from the ceiling and are raised and lowered by electric hoists. Horizontal strings are stretched across the laboratory by means of three-ton winches, the height above floor level being adjustable up to 40ft. The impulse generator can give a momentary increase in voltage up to 2¼ million volts, later to be extended to three million volts, if required.

The standard of measurement for voltage is a two-metre diameter sphere gap arranged vertically. The upper live sphere is suspended from the ceiling by a long string of insulators. A hand winch controls its height; fine adjustment of the sphere gap is effected by varying the height of the lower sphere by means of a motorised screw drive. An alternative method of impulse voltage measurement is by means of a capacitor potential divider and sealed-off cathode-ray tube. Oscillograms of waveshape are recorded on 35 mm film processed in the laboratory dark room.



This machine is employed for testing post type insulators



General view of the thermal cycle test room

Power frequency alternating voltage to a maximum of 1·3 million volts is obtained from two 1·2/650 kV testing transformers connected in cascade. This arrangement can reproduce the rather more sustained strains caused by switching surges of up to two or three times normal.

The mechanical testing equipment in the laboratory is designed to apply appropriate loads to all types of insulators and fittings so that their likely behaviour in service may be gauged. For most ultimate strength tests a hydraulically operated Avery tensile testing machine is used. This has a maximum capacity of 50 tons. A post type insulator testing machine is also installed. This can apply tension, torsion, cantilever and vibrating cantilever loads to single- and multi-unit posts.

Tests, by either impulse or power frequency voltages, on insulator strings can be performed either dry or wet. For wet tests, water of controlled electrical conductivity is fed to rain sprays suspended from the ceiling and falls at a uniform rate on the insulators under test.

The laboratory is responsible also for a number of other tests outside the main electrical and mechanical field. These include the sample testing of the galvanising of all ferrous metal fittings; sample testing of each consignment of cement used in the assembly of insulators; and the thermal cycle testing of insulators. For this last purpose four water baths are arranged in pairs. Two can be heated up to 96 deg C, and the other two cooled down to 1 deg C. The insulators, housed in metal cages, are rapidly transferred from hot to cold bath and vice versa by motorised pulley block.

Atomic Energy Bulletin

WE have received a copy of the first issue (dated November, 1956) of *Atom*, the monthly information bulletin of the United Kingdom Atomic Energy Authority. It opens with a report of the inauguration of the Calder Hall nuclear power station by H.M. the Queen with brief technical details of the plant. There are a number of news items relating to atomic developments; reports of speeches on the future of atomic power by Sir Edwin Plowden and Sir John Cockcroft; an extract from a paper on the preservation of food by irradiation; and abstracts of patent specifications.

Particulars of the bulletin are obtainable from the Public Relations Branch, U.K.A.E.A., St. Giles Court, London, W.C.2.

Electrical Trade with Egypt

Improvement in British Share before the Suez Dispute

DURING 1955 the total Egyptian imports (including electrical) rose by nearly £E22 million to £E183·2 million, while exports remained unchanged at £E138·4 million, with the result that the unfavourable trade balance widened from £E23·1 million to £E44·8 million. Table 1 shows Egypt's principal suppliers and customers with the United Kingdom in the lead, in spite of an increase in the adverse trade balance by nearly £E10 million to £E15·6 million during the past year.

It will be seen that Egypt's adverse trade balance increased with all Western countries during the past years, but improved considerably with Russia and her satellites. While the Eastern bloc represented only 4·9 per cent of Egypt's total imports in 1954 and 14·3 per cent of her total exports, the corresponding figures for the first half of this year rose to 12·1 and 34·2 per cent respectively. Within the Eastern bloc, Czechoslovakia, as usual, was the spearhead of the economic offensive. Her total exports (including electrical) to Egypt increased from £E6 million in 1954 to £E11·8 million during the first half of this year. These figures include capital goods and electrical equipment for factories supplied in exchange for cotton.

Eastern Germany, through its East Berlin export organisation (DIA), supplied in 1954 transmission line and substation equipment worth some £E800,000. Among some important orders which have gone to Eastern Germany lately are those for the El Atb power station and the erection of a new radio transmitting station. In common with other orders, these were initiated by trade missions, in the first place submitting proposals for economic co-operation in industrial projects. Hungary's electrical industry, very strongly represented in Egypt, among other projects has lately booked orders for the El Tabbin power station in Heluan, and for 93 diesel locomotives for the Egyptian State Railways.

Atomic Power Agreement

Last July Russia signed a co-operation agreement with Egypt for the industrial use of nuclear energy. This agreement stipulates that the two governments will co-operate in research work and its practical applications, the supply of equipment, the exchange of scientists, and the training of Egyptians. The Egyptian Institute for Atomic Research is expected to install by 1958 in its laboratory in Cairo a cyclotron and a 2 MW reactor of Russian origin. The contemplated establishment of a Soviet trade office in Cairo is further proof of Russia's keen desire to expand her trade links.

In Table 2, showing Egypt's electrical imports, the United Kingdom ranks second after Western Germany as Egypt's major supplier. Though trade figures for the Eastern bloc are not available, it played an increasing part in the trade.

Financial Restrictions

The Suez Canal dispute has led to the imposition of payment restrictions upon Egypt by the United Kingdom, France and the United States. Since Egypt finances a large proportion of her trade in sterling and is faced with difficulties in paying for imports, she has made alternative arrangements for financing trade with a number of governments including the Eastern bloc. After a temporary setback during last year, United Kingdom electrical exports to Egypt showed an encouraging upward trend, before the Suez Canal dispute arose. Details of these exports, in Table 3, show the predominance of generating plant and radio and TV equipment.

TABLE 1.—EGYPT'S FOREIGN TRADE WITH PRINCIPAL WESTERN COUNTRIES

Countries	Imports from				Exports to				Trade balance		
	1954		1955		1954		1955		1954	1955	Jan.–June 1956
	£E (mill.)	Per cent	£E (mill.)	Per cent	£E (mill.)	Per cent	£E (mill.)	Per cent	£E (mill.)	£E (mill.)	£E (mill.)
United Kingdom	20·3	12·9	23·6	12·9	14·5	10·5	8·0	5·8	− 6·4	−15·6	−11·6
United States ...	17·8	11·0	22·2	12·1	6·6	4·8	9·1	6·6	−11·2	−13·1	−15·2
France	16·2	10·0	15·9	8·7	15·9	11·5	12·1	8·7	− 0·3	− 3·8	+ 0·4
W. Germany ...	17·9	11·1	19·2	10·2	11·5	8·3	8·0	5·8	− 6·4	−11·2	− 8·0
Italy	12·7	7·9	14·9	8·1	10·5	7·6	7·5	5·4	− 2·2	− 7·4	− 3·6
Switzerland ...	4·8	3·0	7·2	3·9	4·3	3·1	5·5	4·0	− 0·5	− 1·7	− 1·8

TABLE 2.—EGYPT'S PRINCIPAL ELECTRICAL SUPPLIERS (£000)

Country	1954	1955	Jan.–June 1956
United Kingdom ...	1,351	1,887	1,156
United States	440	910	505
W. Germany	2,520	2,731	1,217
Holland	981	1,260	730
Sweden	250	701	622
Total	7,630	10,640	4,900

TABLE 3.—UNITED KINGDOM ELECTRICAL EXPORTS TO EGYPT (£000)

Product	1954	1955	Jan.–June 1956
Generating plant	72·1	214·2	258·2
Steam and water turbines	15·0	17·2	2·0
Steam condensers	22·9	15·1	5·2
Motors	52·2	82·4	31·5
Control gear	8·9	7·7	7·3
Transformers	10·2	13·5	5·3
Switchgear	29·6	124·0	45·8
Convertors	1·8	0·4	0·7
Rectifiers	1·7	4·4	0·1
Welding plant and electrodes	60·5	60·0	52·2
Heating, cooking, and domestic appliances	22·6	30·8	7·5
Refrigerators	63·4	82·4	16·1
Fans	11·1	15·3	6·5
Instruments and meters	33·6	41·9	25·6
X-ray and medical appliances	5·9	7·1	10·1
Radio and TV equipment	307·8	316·6	141·0
Telecommunication equipment	39·0	59·0	—
Miscellaneous	592·9	795·9	520·5
Total	1,351·4	1,887·9	1,156·1

Financial Section

STOCKS and SHARES

CONDITIONS in the Stock Exchange have of course continued to be determined by the political news. According to its tenor, stock and share quotations have veered towards one side or the other, but without violence, and with a notable absence of heavy selling pressure even in the most anxious phases. In the gilt-edged market, War Loan was down at one time to 68¾, the lowest quotation ever recorded in its present form, but had picked up to over 70 by the beginning of this week. Industrial share prices, measured by the indices, had depreciated at that stage by about 6 per cent since the Suez troubles first broke at the end of July. Events have put a check for the time being upon the flow of new issues.

Profit Margins

Although political developments have pushed into the background the economic and business news which ordinarily has the main influence on the home industrial market, the evidence of shrinkage in company profit margins has been persistent enough to secure close attention. Most of it is coming from the relatively new institution of half-yearly progress reports by industrial firms. Among the latest of these is the statement from the Brush Group, which echoes previous announcements from A.E.I., I.C.I. and a number of others, in reporting that an increase in turnover during the first six months of the year has been accompanied by rising production costs —wages, salaries and materials—and by a consequent narrowing of the margin of profit, particularly in the competitive markets overseas. In this case the Brush Group, which made a 3 per cent interim distribution at this time last year, is postponing consideration of an ordinary dividend until results for the full twelve months are available. The 5s shares were subsequently quoted lower at par.

Falk Stadelmann

Annual results published by Falk Stadelmann show no more than a small setback in earnings, following the big expansion of the previous year, and the group's net surplus of about £175,000 covers more than twice the ordinary dividend, which is brought up to a total of 17½ per cent, as before. The £1 shares, which had risen half-a-crown to 38s 9d in advance of the report, were little changed subsequently. At this level the yield works out at 9 per cent. From the report it emerges that the diversity of the group's interests assisted largely in offsetting the difficult trading conditions created in some sections of the business by Government restrictions. Progress is stated to have been made in the field of electrical domestic appliances and lighting, and turnover in general since the end of the financial year in March is reported to have increased further.

Sun Electrical Dividend

The £1 shares of Sun Electrical are generally a quiet market, seldom

Price Changes in

Company or Board	Nom. Value	Middle price 5th Nov.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1956 Highest	1956 Lowest
Gilt-edged Stocks								
Brit. Elec. 1968/73	100	74½		3	3	4 0 6	80½	73½
Brit. Elec. 1974/77	100	73½		3	3	4 1 9	79½	71½
Brit. Elec. 1976/79	100	76½		3½	3½	4 11 6	84	76½
Brit. Elec. 1974/79	100	86½		4½	4½	4 18 3	95	86½
Overseas Electric Supply								
Calcutta Elec.	£1	19/-		6†	6†	6 6 3†	20/9	19/-
East African Power	£1	20/-		7	7	7 0 0	21/3	19/6
Nigerian Elec.	£1	17/6		10	10*	11 8 6	21/-	17/-
Perak Hydro-Elec.	£1	15/-		10	10*	13 6 9	17/6	14/9
Equipment and Manufacturing								
Aberdare Cables	5/-	11/6	−6d	17½	17½	7 12 3	13/6	10/6
Aerialite	1/-	5/9		88½	45*	7 16 6	6/9	4/9
Allen, W. H.	£1	38/9		20	10*	5 3 3	39/-	33/6
Aron Elec. Ord.	£1	55/6		15	15	5 8 0	56/-	53/6
Assd. Automation	10/-	16/9	−3d	10	5	2 19 9	19/-	16/9
Assoc. Elec. Ord.	£1	63/9	−1/3	14	15	4 14 0	85/6	57/9
Automatic Tel. & El.	£1	53/9		15	15	5 11 6	72/6	56/3
Babcock & Wilcox	£1	72/6	−2/6	15	15	4 2 9	85/6	64/-
Baldwin, H. J.	2/-	4/9	−3d	20	20	8 8 6	5/-	3/9
Bakelite	10/-	26/-		16	16	6 3 0	34/-	26/-
Berry's Electric	5/-	6/-		—	10‡	8 6 9	6/6	5/9
British Aluminium	£1	67/6	+9d	12	12	3 11 0	78/9	40/6
B.I. Callender's	£1	50/3	−1/-	10	12½	4 19 6	54/3	45/-
B.I. Callender's 6% Pref.	£1	21/9		6	6	5 10 3	22/6	20/3
British Tabulating	£1	43/9	−2/6	9	9	4 2 6	51/3	37/3
British Thermostat	5/-	25/-		20	25	5 0 0	31/9	24/6
British Vac. Cleaner	5/-	8/-		30	15*	9 7 6	8/9	6/-
Brook Motors	10/-	35/-		20	25	7 2 9	44/-	31/9
Brush Group	5/-	5/-	−9d	10	10	10 0 0	7/9	5/-
Bulgin, A. F.	1/-	4/9		45	50	—	5/3	4/3
Burco Dean	5/-	9/6	−3d	—	22½	11 16 9	13/6	8/3
Chloride El. Storage "A"	£1	61/3	−1/3	17½	17½	5 14 3	73/6	60/9
Clarke Chapman	£1	116/3		20	22½	3 17 6	123/-	89/6
Cole, E. K.	5/-	16/-	−3d	17½	17½	5 9 6	22/3	15/6
Cossor, A. C.	5/-	6/-		15	Nil	Nil	10/3	5/-
Crabtree	10/-	24/6		20	20	8 3 3	29/3	24/-
Crompton Parkinson Ord.	5/-	13/3		16	16	6 0 9	15/-	12/3
De La Rue	5/-	16/-	−3d	30	30	9 7 6	20/3	15/-
Decca "A"	4/-	26/3	−1/3	56½	43¾*	6 13 3	44/9	24/9
Desoutter	5/-	31/-		25	30	4 16 9	32/9	25/9
Dewhurst	2/-	5/6		24	30	—	7/6	5/3
Dictograph Tel.	2/-	7/3		20	20	5 10 3	6/9	5/6
Dubilier Condenser	1/-	5/3		25	30	5 14 3	5/3	3/6
Duport	5/-	18/9	−6d	23	25‡	6 13 3	21/6	13/9
E.M.I.	10/-	26/-x.d.		15	15	5 15 6	37/-	25/6
Electrical Components	5/-	7/6x.c.		25	25	8 6 9	8/-	6/3
Elec. Construction	£1	23/9		8½	8½	7 2 3	29/9	23/9
Elliott Bros.	5/-	25/-	−2/6	19	17½*	3 10 0	36/9	24/6
Enfield Cable Ord.	£1	15/-		Nil	Nil	Nil	19/3	13/6
English Electric	£1	47/6		12½	12½	5 5 3	66/3	45/-
English Electric 3¾% Pref.	£1	13/-		3¾	3¾	5 15 6	14/6	12/6
Ericsson Tel.	5/-	34/6	−1/-	20†	20†	2 18 0†	42/9	33/6
Ever Ready	5/-	28/3x.d.		35	35	6 4 0	32/9	24/-
Falk Stadelmann	£1	38/9		17½	17½	9 0 9	45/9	36/9
G.E.C. Ord.	£1	43/9	−1/3	12½	14	6 8 0	65/6	42/6
G.E.C. 6½% Pref.	£1	22/-		6½	6½	5 18 3	23/9	21/3
General Cables	5/-	11/9	−6d	30	30	12 15 0	13/9	11/3
Greenwood & Batley	£1	46/3		17½	17½	7 11 3	47/6	45/-
Hackbridge Holdings	5/-	22/3		25	30	6 14 9	24/6	18/9
Hackbridge & Hewittic	5/-	17/6		30	23*	6 11 6	22/-	17/3
Heatrae	2/-	3/9		15	15	8 0 0	5/1	3/9
Henley's	10/-	15/3	−6d	10½	11½	7 10 9	19/9	14/-
Holophane	5/-	19/9x.d.		30	30	7 12 0	21/6	17/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend forecast.

varying much in price, and remained virtually unaltered at 37s 6d after the announcement of the final dividend and results for the year ended last April. Earnings for this period have followed up the advance of the previous year with a further improvement of 50 per cent to £68,000. The dividend for the year is being maintained at 20 per cent, and a 5 per cent bonus is added this time. The total 25 per cent appears to absorb little more than one-fifth of the distributable surplus, after allowing for the preference dividend. On the basis of the increased distribution, the yield on the shares goes up to over 13 per cent.

Plessey Company

The Plessey Company is due to announce this month its final dividend and annual results, which will cover the twelve months ended in June. This year's distributions are payable on ordinary capital increased to £1·2 million as a result of the substantial "rights" issue of shares in February, which raised the best part of £2 million new money for the continued development of the business. At that time the directors indicated interim and final dividends each of 15 per cent on the larger capital, of which the former has duly been paid. The forecast was made with the usual reservations about changes in conditions during the remainder of the period. At 67s 6d the 10s shares yield about 4½ per cent on the dividend basis indicated. They were quoted at up to 87s 6d in the early part of this year, and since the share issue have moved between extremes of 73s 3d and 56s.

Watford Electric Issues

The shareholders of Watford Electric & Manufacturing are being offered 86,000 new 6 per cent preference and 201,000 new 2s ordinary shares, mainly in order to finance the expansion of production and research facilities. The new ordinary shares are being dealt in at a premium of about 1s 3d on the issue price of 4s 9d. They became fully-paid yesterday (Thursday) and will be available free of transfer stamp until near the end of the month. On the assumption of a dividend at the present annual rate of 25 per cent, the yield at an all-in price of 6s comes to 8¼ per cent. The new 6 per cent 10s preference shares are quoted at a fraction above the issue price of 10s. This issue is covered, as to the principal amount, more than three times by the net assets of the group.

Prior Charges

In the lists of industrial debenture, loan and preference stocks on offer, the new G.E.C. 6 per cent loan stock has been available recently at about 102¾, to yield 5·8 per cent, and the new Ever Ready 5¾ per cent debenture at a fraction over 100. In both cases stock is at present transferable free of stamp duty. Yields of 6 per cent or more remain fairly common among well-covered preference shares. On Electric & Musical Industries 5½ per cent preference at 17s, and Marryat & Scott "sixes" at 18s 6d, the return is just on 6½ per cent. Yields in the neighbourhood of 6¼ per cent are shown by Reliance Clifton "fives" at 16s 6d, General Cable 10s "sixes" at 9s 9d and Telephone & General Trust 7 per cents at 22s 3d. On James Scott 6½ per cent preference at 18s and British Vacuum Cleaner 7½ per cents the yield exceeds 7 per cent.

Electrical Investments

Company or Board	Nom. Value	Middle price 5th Nov.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Equipment and Manufacturing—continued						£ s d		
Hoover	5/-	23/6	−1/-	70	50	10 12 9	39/3	23/-
I.C.I.	£1	40/3		10	10	4 19 6	49/9	39/9
Intl. Combustion	5/-	18/9	−9d	25	20*	5 6 9	25/-	15/3
Johnson & Phillips	£1	37/6	−9d	15	15	8 0 0	46/6	37/6
Lancashire Dynamo	£1	40/-	−1/3	15	11*	5 10 0	49/9	40/-
Laurence, Scott	5/-	15/3		12½	15	4 18 3	16/9	13/3
Lister, R. A.	£1	27/3	−1/-	9·3	10	7 6 9	35/3	27/3
London Elec. Wire	£1	45/-	−6d	12½	12½	5 11 0	52/9	45/-
Lucas, J.	£1	29/6	−1/9	7½	7½	5 1 9	40/3	29/6
Marryat & Scott	2/-	9/6		30	30	6 6 3	11/3	9/6
Mather & Platt	£1	54/6	−6d	15	15	5 10 0	65/3	51/6
Metal Industries	£1	25/6		9	9	—	27/-	16/3
Midland Elec. Mfg.	£1	45/-		10	12½	5 11 0	48/6	43/6
Morphy-Richards	4/-	25/-x.d.		50	50	8 0 0	27/3	20/-
Murex	£1	68/3	−2/3	20	20	5 17 3	74/6	60/-
Newman Ind.	2/-	2/3		10	10	8 17 9	2/9	2/1
Oldham & Son	1/-	2/6		20	17½*	7 0 0	3/-	2/3
Parnall (Yate)	5/-	6/6	+3d	14	12	9 4 6	9/6	5/6
Parsons, C. A.	£1	90/-	−2/6	10	10	2 4 6	96/-	61/6
Plessey	10/-	67/6		27½	30‡	4 9 0	87/6	56/-
Pye "A" Deferred	5/-	15/9	+3d	12½	12½	3 19 3	21/3	14/-
Reyrolle	£1	100/-		15	16½	3 5 0	117/6	81/-
Rheostatic	4/-	9/9		18½	12‡	4 19 0	—	8/3
Richardsons Westgarth	5/-	15/6	−6d	16½	16½	5 7 6	17/-	13/9
Scottish Cables	4/-	15/3	−6d	27½	27½	7 4 3	17/9	15/3
Smith (England), S.	4/-	11/-		17½	17½	6 7 3	14/3	10/6
Southern Areas	£1	15/-		10	7½	10 0 0	28/9	15/-
Strand Elec.	5/-	8/3		15	15	9 1 9	8/6	6/9
Sturtevant	5/-	23/6		14·4†	15†	3 3 9†	31/3	22/6
Sun Elec.	£1	37/6		20	25	13 6 9	37/6	33/9
Switchgear & Cowans	5/-	12/9	−3d	20	25	9 16 0	17/-	12/9
Taylor Tunnicliff	5/-	12/3	−6d	15	15	6 2 6	14/-	11/3
T.C.C.	10/-	36/3		25	25	6 18 6	45/-	36/3
T.C. & M.	£1	27/-		8½	8½	6 6 0	34/-	26/-
Telephone Mfg.	5/-	7/-		10	10*	7 2 9	8/6	6/3
Thorn Elec.	5/-	17/6		15	15	4 5 9	22/6	16/-
Thornycroft	£1	36/3	−3/9	15	12½	6 18 0	49/9	36/3
Tube Investments	£1	56/3		22½	14*‡	4 19 9	70/6	54/9
Vactric	5/-	13/-	−6d	15	17½*	6 14 6	15/-	11/6
Veritys	5/-	9/-		12½	12½	6 19 0	10/-	6/9
Walsall Conduits	4/-	12/3	−6d	70	20*	6 10 6	13/6	10/9
Ward & Goldstone	5/-	37/6		30	35	4 13 3	39/6	29/-
Watford	2/-	5/9	−9d	25	25	8 13 9	7/6	5/9
Westinghouse	£1	72/6		18	18	4 19 3	100/-	71/6
West, Allen	5/-	11/9	−3d	15	15	6 7 9	14/6	11/6
Wolf Electric	5/-	17/6		20	20	5 14 3	26/3	17/6
Trusts, Transport and Communications								
Anglo-Portuguese	£1	22/3		8	8	7 3 9	23/6	20/3
British Elec. Traction: Def. Ord. "A"	5/-	17/6	−6d	22½	22½	6 8 6	20/-	15/6
Cable & Wireless: Ord.	5/-	10/6		10	10	4 15 3	11/3	9/6
4% Loan	100	91		4	4	4 8 0	92½	88
Calcutta Trams	£1	26/9		6†	7½†	5 12 3†	27/6	23/-
Cape Elec. Trams	£1	16/3		8	8	9 17 0	20/3	18/-
Marconi Marine	£1	31/6x.d.		10	10	6 7 0	34/-	31/-
Oriental Tel. Ord.	1/-	70/-		16	—	—	90/-	67/6
Telephone Rentals	5/-	10/9	−3d	12½	12½	5 16 3	11/9	9/9

REPORTS and DIVIDENDS

Falk, Stadelmann & Co., Ltd.—The accounts for the year ended 31st March last show a trading profit of £607,569, as compared with £629,077 for the preceding year, which with sundry income, makes £608,387. After deducting depreciation, etc., and £230,369 for taxation, the net balance is £185,391 (against £219,008). Of this £10,827 is required for minority interests and £60,054 is retained by subsidiaries, leaving £114,510 to be dealt with in the accounts of the parent company. The dividend for the year is maintained at 17½ per cent by a final payment of 10 per cent, contingencies reserve receives £15,000 and the pension fund £10,000. The balance carried forward in the parent company is £101,389 (£95,766) and the group carry-forward is £372,087 (£328,397).

Mr. H. Falk (chairman) says that a considerable drop in the production of gas appliances, due to the credit squeeze, resulted in the lower profit, although the greater part of the reduction in sales and profits on such appliances was made good by increases in other sections. The cable works again achieved a record output and sales, both at home and abroad. Rapid fluctuations in raw material prices, mainly copper and rubber, have, however, caused considerable difficulties and shareholders are warned that it seems likely that stock losses will have to be taken into the accounts for the current year.

George H. Scholes & Co., Ltd.—The annual meeting was held on 30th October in Manchester, Mr. F. J. Pearce (chairman and managing director) presiding. In his circulated statement, Mr. Pearce said that by more economical use of labour and materials they had been able to absorb increased costs without increasing their selling prices. Sales during the year under review created a new record, though a temporary recession was experienced during the spring, which resulted in the building up of stocks, but these were rapidly reverting to normal. They had during the past year installed up-to-date machinery and introduced new processes, making savings which were not last year fully reflected in the profits but which would have an effect in the succeeding years. With regard to the current year, they had got off to a good start and, given freedom from outside troubles, he felt they could better their performance of last year. They had developments in hand for new products which, when they were ready, would help their sales.

The Brush Group, Ltd., is not paying an interim dividend. The board is postponing consideration of an ordinary dividend payment until the results for the full year 1956 are available. Last year there was an interim dividend of 3 per cent and a final of 7 per cent. It is stated that the turnover of the group factories during the first six months of this year has exceeded in amount that for the same period last year, but costs of production, including wages, salaries and materials, have increased sharply and profit margins have narrowed, particularly in export markets where increased competition is being faced.

The Automatic Telephone & Electric Co., Ltd., has announced that in respect of the issue of 700,000 ordinary shares of £1 each at 46s per share, of which 698,133 were offered to ordinary and deferred stockholders in the proportion of one in three, 677,785 have been taken up by way of rights. There were 22,215 excess shares available, for which applications for 434,923 shares were received. Applications for up to 20 shares have been allotted in full. All other allotments of excess shares were made by ballot, each successful applicant receiving 20 shares.

The British Electric Resistance Co., Ltd., reports that after providing £27,300 for taxation, the net profit for the year to 31st July last is £22,255, as compared with £21,130 for the preceding year. General reserve receives £10,000 and the dividend for the year is maintained at 20 per cent by a final payment of 15 per cent. The balance carried forward is £9,560 (against £14,805 brought in).

Veritys, Ltd.—A committee of shareholders is being formed to consider any proposals that the board may make in the near future regarding an offer made by the Limit Engineering Group, Ltd. The committee consists of Messrs. H. J. Grant, C. A. Dupree and R. M. Mair and the secretaries are T. Maylam & Co., Medway Wharf, Tonbridge.

The British Electric Traction Co., Ltd., has announced an interim dividend of 7½ per cent (unchanged).

Cable & Wireless (Holding), Ltd., is paying a third interim dividend of 2½ per cent, making 7½ per cent to date.

W. Canning & Co., Ltd., have declared an interim dividend of 5 per cent (unchanged).

G. & J. Weir, Ltd., are maintaining their interim dividend at 7½ per cent.

The Atlas Electric & General Investment Trust, Ltd., has declared an interim dividend of 3 per cent (unchanged).

New Companies

Rosite, Ltd.—Registered 25th October. Capital £30,000. Manufacturers of and dealers in electrical insulating materials, etc. Directors: A. G. Clark, A. E. Underwood and F. Beacroft. Regd. office: 56, Vicarage Lane, Ilford, Essex.

J. F. Foord, Ltd.—Registered 25th October. Capital £1,000. Electrical engineers and general electrical installation contractors, radio and television engineers, etc. J. F. Foord is managing director. Regd. office: Post Office Chambers, Ellesmere Port, Wirral.

Lacona, Ltd.—Registered 25th October. Capital £100. Electrical engineers and contractors, manufacturers of and dealers in radio and television apparatus, etc. J. Hendry is the first director. Regd. office: 80b, Cranbrook Road, Ilford, Essex.

Dougal & Railton, Ltd.—Registered 24th October. Capital £2,000. Electrical engineers, electrical wiring and installation contractors, dealers in radio apparatus, etc. Directors: J. D. Dougal and T. O. Railton. Regd. office: 17, Ridley Place, Newcastle-on-Tyne.

Amersham Electrical, Ltd.—Registered 24th October. Capital £1,000. Electrical engineers and contractors, manufacturers and servicers of and dealers in radio, electrical and mechanical apparatus, etc. Directors: D. G. Pickup and T. Barker. Regd. office: London Road, Amersham, Bucks.

Patersons of Carluke, Ltd.—Registered in Edinburgh 23rd October. Capital £10,000. To acquire the business of electrical, radio and television engineers and dealers in electrical, radio and television equipment now carried on by the representatives of the late Thomas Paterson and Partners, at 44-46, High Street and 19, Cassels Street, Carluke. Directors: J. K. Paterson, J. Garfield, M. R. Paterson, M. W. Tiplady and R. W. Stewart.

R. R. Mills & Co., Ltd.—Registered 30th October. Capital £1,500. To acquire the business of R. R. Mills & Co., carried on by R. R. Mills and A. M. Dawson at Chatham, and to carry on the business of electrical, radio and electronic contractors, engineers, etc. Directors: R. R. Mills, C. S. Whitehead and A. M. Dawson. Regd. office: 267, Castle Road, Chatham, Kent.

Express Re-winds & Replacements, Ltd.—Registered 29th October. Capital £800. Coil winders, electrical engineers, etc. Directors: R. F. Kybird, C. F. Kybird and E. S. Couzens. Regd. office: 76, Oak Street, Norwich, Norfolk.

A. C. Ward Electrical, Ltd.—Registered 27th September. Capital £1,500. Manufacturers of and dealers in radio, electrical and mechanical apparatus of all kinds, etc. Directors: E. J. Daws and A. C. Ward. Regd. office: 46, Strafford Road, Acton, W.3.

Increases of Capital

Dubilier Condenser Co. (1925), Ltd.—Increased by £150,000, in 1s ordinary shares, beyond the registered capital of £500,000.

Heatovent Electric, Ltd.—Increased by £27,000, in £1 ordinary shares, beyond the registered capital of £3,000.

Liquidation

Ward's Electrical Services (Westergate), Ltd.—In voluntary liquidation. Meetings of members and creditors on 5th December at Lane House, Walton Avenue, Bognor Regis, Sussex, to receive an account of the winding-up by the liquidator, Mr. N. F. Trayler.

Bankruptcies

W. A. C. Peacock, trading as W. A. C. Peacock & Son at 49, Burkitt Street, King's Lynn, Norfolk.—Receiving order made 22nd October on debtor's own petition.

R. E. Kelly, lately carrying on business at 10-12, Holloway Head, Birmingham, under the style of B. K. Electrical Co., manufacturers of electric fires.—Public examination 5th December at the Court House, Corporation Street, Birmingham.

C. J. Ekland, formerly carrying on business at 15, Bear Street, Barnstaple, Devon, electrical contractor.—Public examination 16th November at 4, Elliot Street, The Hoe, Plymouth.

G. H. Evans, radio, electrical and television engineer, High Street, Mayfield, Sussex.—Last day for receiving proofs for dividend 9th November. Trustee, Mr. J. S. Bradley-Hole, 7, Old Steine, Brighton, 1.

NEW ELECTRICAL EQUIPMENT

Barrel Pump

The latest addition to the range of portable electric barrel pumps obtainable from the BRITISH CENTRAL ELECTRICAL CO., LTD., 6 & 8, Rosebery Avenue, London, E.C.1, is suitable for use with most acids, alkalis and other liquids that have previously been beyond the scope of the standard barrel pump.

The new pump is known as type 300 SR and is of similar construction to the present model. Whilst the motor housing is of aluminium alloy as previously, the lifting tube and all metal parts which would normally be in contact with the liquid being pumped are in stainless steel, containing a high percentage of chromium. This material resists the attack of sulphuric and silicic acids among others. The pump is self-priming and has a lifting tube 3ft 11in long and 1⅛in diameter, suitable for insertion in standard acid containers. The output is approximately 1,600 to 2,000 gal/hr against a 12ft head. Models are available for 42, 110 and 240 V d.c. and single-phase a.c. operation, the consumption of the motor being 260 W. It is not intended for use with inflammable liquids.

Whilst stainless steel accessories are not at present available, plastic hose or sweetened hose for use with consumable liquids can be supplied, also hose for special applications. The pump is priced at £54.

Electronic Hardening Plant

A new crankshaft hardening plant has just been put on the market by RADIO HEATERS, LTD., Eastheath Avenue, Wokingham, Berks. The plant is normally fed by a Radyne C500 50 kW induction heating equipment which operates at 450 kc/s. The hardening unit is constructed on a heavy steel frame finished in high gloss stove enamel. A heavy steel tank accommodates a jig plate on which are mounted the heating inductors for the particular type of crankshaft being hardened. Different crankshafts are handled by replacement of the complete jig plate and the drawer containing the process timers which fix the heating and quenching cycles for each particular crankshaft.

A control panel on the front of the unit provides the facilities for automatic or manual operation. Once the crankshafts have been loaded, the heating and quenching cycle is completely automatic. The inductor coils are hinged and connected in parallel. Air rams close each coil in turn so that r.f. power is fed to only one coil at a time.

An automatic switching mechanism enables the heating and quenching cycles to be conducted on different bearings simultaneously. In addition, an automatic rematching unit enables maximum loading to be maintained on the generator throughout the heating cycle. At the end of each heating cycle water floods over the heated surface and at the same time the r.f. power is switched to a coil on the other crankshaft. At the conclusion of the whole cycle one crankshaft is removed and the other moved into its position. A new crankshaft is then placed on the empty jig. Jig plates are available for crankshafts from 25in to 42in long, of either two or three throw.

Industrial Vacuum Cleaner

The "Powervac" model EME 33 vacuum cleaner introduced by POWERVACS, LTD., 6, Cockhill, London, E.1, is suitable for factory use. Suction power is derived from a multi-stage turbo-exhauster 1 h.p. universal motor enclosed in a steel container and the dust is collected into a large and easily removable bag.

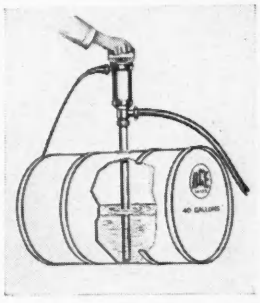
Being compact and mounted on three rubber-tyred ball-bearing castors, the cleaner can easily be wheeled between gangways with a minimum of effort. Floors, walls, trusses, fluorescent fittings, etc., present no problem and can readily be cleaned with the aid of this cleaner. It can also be instantly converted for blowing, giving a powerful jet of clean dry air for cleaning motors, switchgear, etc., and for spraying. It measures 38in high and 15in in diameter and the weight is 115 lb. The price is £88 15s.

Overhead Radiant Heater

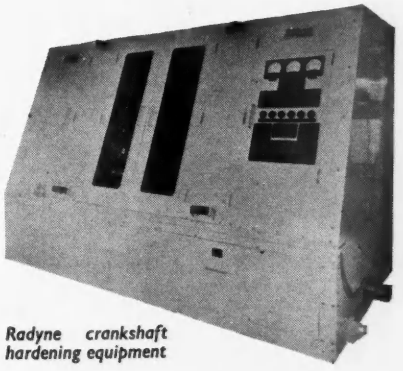
An overhead radiant heater designed to provide warmth where needed in situations where the whole area is too big to be heated economically has been developed by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2. Since the heat source is radiant, comfort conditions are obtained at a lower air temperature and at a reasonable cost.

The heater consists of a rigid anodised aluminium reflector trough fitted with G.E.C. "Inconel" sheathed wire elements. It is available with loadings of 1½ kW and 3 kW. The trough is designed so that another element can be added to a 1½ kW heater to give an output of 3 kW, if required, without further alteration to the trough.

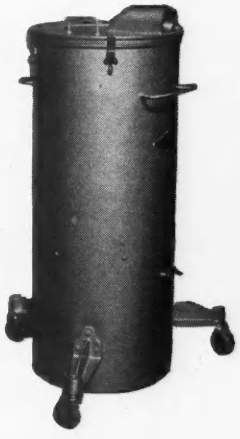
Both 1½ kW and 3 kW heaters have overall dimensions of 40in by 10½in by 3⅜in, and are supplied in the voltage ranges: 200/220 V, 230/240 V and 250 V. The price of the 1½ kW heater is £8, and that of the 3 kW unit £11. The heaters are designed for industrial and commercial application and are consequently not subject to purchase tax.

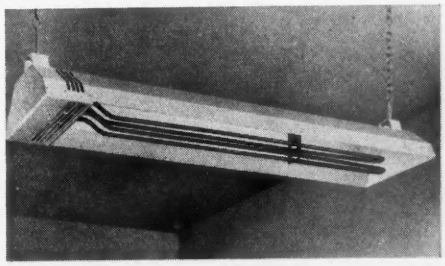


B.C.E. 300 SR barrel pump



Radyne crankshaft hardening equipment





Above: G.E.C. overhead radiant heater

Left: "Powervac" model EME 33 industrial vacuum cleaner

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 14th November from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

20154. National Research Development Corporation.—Apparatus for use in electric or electronic digital computing machines. 10th August, 1951. (761121.)

1951

16870. Yardney International Corporation.—Manufacture of plates for electric batteries and accumulators. 16th July, 1952. (761339.)

1952

16052. Eastman Kodak Co.—Electro-optical colour reproduction. 26th June, 1952. (761342.) 20597. Electronic colour-correction apparatus for scanning systems. 15th August, 1952. (761538.)

17461. Teddington Aircraft Controls, Ltd. —Pressure operated electric switch. 6th August, 1953. (761231.)

24810. International Business Machine Corporation.—Electronic counter. 3rd October, 1952. (761123.)

29813. Radio Corporation of America.—Colour television apparatus. 25th November, 1952. (761433.)

31165. Mullard Radio Valve Co., Ltd.—Television receiver circuits. 9th December, 1952. (761347.)

1953

3338. Rolls-Royce, Ltd.—Electrical resistance welding apparatus. 4th May, 1954. (761434.)

8486. National Research Development Corporation.—Voltage stabilising circuits. 28th June, 1954. (761546.)

11413. Sangamo Weston, Ltd.—Current regulating systems. 24th April, 1953. (761236.)

13613. Telefunken Ges.—Television receivers. 15th May, 1953. (761438.)

16181. Electric & Musical Industries, Ltd. —Metal envelope cathode-ray tubes and mountings therefor. 22nd April, 1954. (761439.)

17825. General Electric Co., Ltd., Dennis, H. M., and Polgreen, G. R.—Magnetic recording media. 22nd June, 1954. (761451.)

19272. Associated Fumigators, Ltd.—Electric light bulbs for disseminating gases, vapours or aerosols. 2nd July, 1954. (761551.)

19571. Winston Electronics, Ltd.—Controlled voltage rectifying apparatus. 14th July, 1954. (761239.)

21600. Standard Telephones & Cables, Ltd.—Contact spring pile-ups for electromagnetic relays. 5th August, 1953. (761136.)

22383. Dussek Bros. & Co., Ltd.—Impregnating compositions for use in the manufacture of electric cables and condensers. 8th July, 1954. (761363.)

23030. MacKenzie, M.—Testing of the location of a conductor within an insulating covering. 17th August, 1954. (761241.)

24527. Holophane, Ltd.—Lighting fittings. 6th December, 1954. (761365.)

24600. Electric & Musical Industries, Ltd.—Waveguides and transmission lines for high frequency electro-magnetic energy. 6th September, 1954. (761366.)

24854. General Electric Co., Ltd., and Tombs, N. C.—Manufacture of permanent magnets. 20th August, 1954. (761459.)

25523. British Thomson-Houston Co., Ltd.—Electric transformer windings. 19th August, 1954. (761245.)

25857. General Electric Co.—Methods of electrolytic oxidation of copper. 18th September, 1953. (761372.)

26018. General Electric Co.—Composite electrical insulation. 21st September, 1953. (761563.) 26019. Insulated electric conductors. 21st September, 1953. (761373.) 26020. Coaxial high frequency conductors. 21st September, 1953. (761374.)

26724. Cinema-Television, Ltd.—Deflecting arrangements for cathode-ray tubes. 29th September, 1954. (761461.)

27298. General Electric Co., Ltd., Little, J. G., and Rous, R. F.—Multi-channel electric pulse time modulation signalling systems. 29th September, 1954. (761246.)

28115. Plessey Co., Ltd.—Electromagnetic indicators. 13th October, 1954. (761247.)

28495. Igranic Electric Co., Ltd.—Overload released electric switches, motor starters and the like. 15th October, 1953. (761564.)

28928. Standard Telephones & Cables, Ltd.—Circuits for cathode-ray oscilloscopes. 20th October, 1953. (761375.)

29211. Fernseh Ges.—Secondary electron multipliers. 22nd October, 1953. (761463.)

29367. British Thomson-Houston Co., Ltd.—Pictures presenting a three dimensional effect. 22nd October, 1954. (761464.)

30096. Standard Telephones & Cables, Ltd.—Timing equipment. 30th October, 1953. (761566.)

34559. Stiebel, T. H.—Electrical hot water generator. 11th December, 1953. (761254.)

34904. Mullard Radio Valve Co., Ltd.—Digital record-controlled apparatus. 28th October, 1954. (761570.)

34905. General Electric Co., Ltd., and Harwood, A. E. J.—Protective arrangements for a.c. circuits. 9th December, 1954. (Cognate application 13259, 6th May, 1954.) (761470.)

35545. Turner, Ltd., E. R. & F.—Induction motors. 21st December, 1954. (761573.)

1954

57. English Electric Co., Ltd.—Liquid resistance controllers. 31st December, 1954. (761258.)

770. British Thomson-Houston Co., Ltd. —Electronic control circuits. 30th December, 1954. (761574.)

1694. Grafton, C.—Electric lighting systems. 13th January, 1955. (761576.)

4077. Teddington Aircraft Controls, Ltd. —Electric intervalometers. 3rd May, 1955. (761485.)

6018. Bobkowicz, E.—Dry shavers. 2nd March, 1954. (761265.)

6248. General Electric Co., Ltd., and Page, B. H.—Electric blowers. 3rd March, 1955. (761583.)

8151. Sunbeam Corporation.—Electrically heated coffee percolator. 19th March, 1954. (761268.)

10324. Coventry Radiator & Presswork Co., Ltd.—Stowage for a three-pin electrical plug. 15th December, 1954. (761448.)

12019/20. British Thomson-Houston Co., Ltd.—Electric generating equipment. 26th April, 1955. (761449/50.)

12246. Siemens & Halske Akt.-Ges.—Circuit arrangements for teleprinter switching installations with selection by teleprinter impulse combinations. 27th April, 1954. (761471.)

12326. British Thomson-Houston Co., Ltd.—Light signalling devices. 28th April, 1954. (761398.)

12852. England, A. K.—Domestic electric water heaters. 23rd May, 1955. (Cognate application 15406, 25th May, 1954.) (761599.)

13161. Philips Electrical Industries, Ltd. —Camera tubes. 5th May, 1954. (761601.)

13717. Western Electric Co., Inc.—Microwave devices. 11th May, 1954. (761279.)

14484. Turner Electrical Instruments, Ltd., E.—Indicating instrument mountings. 12th May, 1955. (761605.)

14584. General Electric Co.—Polyphase current supply sources. 18th May, 1954. (761476.)

16770. Standard Telephones & Cables, Ltd.—Overthrow prevention devices operated by a power driven device. 7th September, 1955. (761403.)

17130. Radio Corporation of America.—Methods of and means for converting the energy of nuclear radiations into useful electrical energy. 10th June, 1954. (761404.)

17606. Bulova Watch Co., Inc.—Electronic device for the operation of a timepiece movement. 15th June, 1954. (761609.)

18967. Union Carbide & Carbon Corporation.—Impregnated carbonaceous electrical contact brush. 29th June, 1954. (761406.)

20159. Philco Corporation.—Method of manufacturing the screen structure of cathode-ray tubes. 9th July, 1954. (761180.)

20669. Chloride Electrical Storage Co., Ltd.—Primary electric batteries. 26th May, 1955. (761290.)

21401. Plessey Co., Ltd.—Electric transformers. 22nd July, 1955. (761291.)

23484. Geipel, S.—Electric cables. 27th July, 1955. (761622.)

24108. Jeudi, G.—Electric welding. 18th August, 1954. (761504.)

24297. Philips Electrical Industries, Ltd. —Circuit arrangements for amplifying electric signals. 20th August, 1954. (761298.)

25680. Aluminium-Walzwerkesingen Ges. —Electrolytic oxidation of etched anodes of electrolytic capacitors. 3rd September, 1954. (761196.)

26418. Erie Resistor Corporation.—Dielectrics. 13th September, 1954. (761307.)

26591. Radio Corporation of America.—Colour-correction systems. 14th September, 1954. (761416.)

26999. English Electric Co., Ltd.—Commutators for dynamo-electric machines. 9th September, 1955. (761626.)

27147. Philips Electrical Industries, Ltd. —Television cameras comprising a pick-up tube which is detachably secured in a frame adapted to be removed from the camera. 20th September, 1954. (761309.)

27329. Compagnie Générale d'Electricité. —Insulating and supporting member for the windings of electro-magnetic induction apparatus. 21st September, 1954. (761310.)

27424. Mallory Batteries, Ltd.—Electric battery construction. 22nd September, 1954. (761629.)

28116. British Thomson-Houston Co., Ltd.—Ignition apparatus. 16th September, 1955. (761419.)

29066. Research Corporation.—Electrostatic precipitators. 8th October, 1954. (761514.)

30726. Laurence, R. F.—Photometers employing a filament lamp as a comparison source. 5th May, 1955. (761634.)

32142. Radio Corporation of America.—Semi-conductor devices and method of making same. 5th November, 1954. (761516.)

33293. Philips Electrical Industries, Ltd. —Impulse converting circuit arrangements employing transistors. 17th November, 1954. (761331.)

35038. International Business Machines Corporation. — Self-complementing gaseous electronic discharge storage or counting tube. 3rd December, 1954. (761520.)

35442. Compagnie Générale d'Electricité. —Electric cables. 7th December, 1954. (761642.)

36103. National Cash Register Co.—Electronic digital serial adder. 14th December, 1954. (761522.)

36869. Ruben, S.—Electric potential producing cell. 21st December, 1954. (761221.)

37181. Krizik-Praha Smichov, Narodni Podnik, Nessel, V., and Forejt, J.—Circuit arrangement for an oscillograph tube. 23rd December, 1954. (761525.)

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged.

Monday, 12th November

BIRMINGHAM. — Imperial Hotel, 6 p.m. I.E.E. South Midland Supply & Utilisation Group. Informal lecture on "American Power Station Practice," by G. F. Kennedy.

CARDIFF.—At the South Wales Institute of Engineers, Park Place, 6 p.m. I.E.E. Western Centre. "Germanium and Silicon Power Rectifiers," by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell.

CHESTER.—Grosvenor Hotel, 6.30 for 7 p.m. I.E.E. Mersey & North Wales Centre. Annual dinner.

HEREFORD.—Farmers' Club, Widemarsh Street, 7.30 p.m. I.E.E. South Midland Centre, Malvern and District meeting. "Colour Television," by Dr. G. N. Patchett.

IPSWICH.—Crown & Anchor Hotel, 6 for 6.30 p.m. I.E.E. East Anglian Sub-Centre. "Atomic Power Stations," by D. F. Welch.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. Institution of Electrical Engineers, informal meeting. Discussion on "Power Factor in Industrial Installations," opened by C. F. Freeman.

White Hall Hotel, Bloomsbury Square, W.C.1, 7.30 p.m. A.S.E.E. Central London Branch. "Interplanetary Science and the Development of the Rocket," by K. L. Ward.

Caxton Hall, S.W.1, 7 p.m. E.P.E.A. London Technical Group. "Capacitors for Power Factor Correction," by H. A. Jones.

NEWCASTLE-UPON-TYNE. — Neville Hall, 6.15 p.m. I.E.E. North-Eastern Centre. "The Control and Instrumentation of a Nuclear Reactor," by A. B. Gillespie.

READING.—George Hotel, King Street, 7.15 p.m. I.E.E. district meeting. Informal discussion on "The Thirteenth Edition of the I.E.E. Wiring Regulations," opened by Forbes Jackson.

SHEFFIELD. — The University, Western Bank, 6.30 p.m. I.E.S. Sheffield Centre. "Trends in Interior Installations and Designs," by H. H. Ballin.

WEMBLEY PARK.—Century Hotel, Forty Avenue, 8.15 p.m. A.S.E.E. North West London Branch. "Modern Lighting," by E. H. Maddox.

Monday, 12th November, to Saturday, 17th November

LONDON.—Olympia. Public Works and Municipal Services Congress and Exhibition.

Tuesday, 13th November

BARROW. — N.W.E.B. Demonstration Theatre, Duke Street, 7.15 p.m. I.E.E. North Lancashire Sub-Centre. "Age and the Incidence of Fires in Electrical Installations," by L. Gosland.

BELFAST.—Queen's University, 6.30 p.m. I.E.E. Northern Ireland Centre. "Highland Water Power—The Developments of the North of Scotland Hydro-Electric Board," by the late T. Lawrie (to be read by an officer of the Board).

BOURNEMOUTH. — Grand Hotel, Firvale Road, 8 p.m. A.S.E.E. Bournemouth Branch. "Lighting," by R. T. O. Freeth.

CAMBRIDGE.—Cavendish Laboratory, Free School Lane, 8 p.m. I.E.E. Cambridge Radio & Telecommunication Group. Radio & Telecommunication Section chairman's address, by Dr. R. C. G. Williams.

EDINBURGH.—11, Atholl Crescent, 7.30 p.m. Edinburgh Electrical Society. "Automobile Electrical Equipment."

LEEDS.—1, Whitehall Road, 7 p.m. I.E.E. North Midland Graduate & Student Section. "Management from Top to Bottom," by W. H. Dunkley.

LONDON.—Café Royal, 6.45 for 7.15 p.m. I.E.E. Measurement & Control Section. Dinner.

Savoy Place, W.C.2, 6.30 p.m. I.E.E. London Graduate & Student Section. Students' lecture, "Digital Computers and how they may help the Engineer," by Dr. M. V. Wilkes.

Magnet House, Kingsway, W.C.2, 6.30 p.m. Association of Supervising Electrical Engineers. London National Lecture: "Electronic Control of Industrial Drives," by E. J. P. Long. (Annual joint meeting with the Institution of Engineers-in-Charge.)

21, Tothill Street, S.W.1, 6 p.m. Illuminating Engineering Society. "The Starting of Fluorescent Lamps," by D. T. Waigh and L. C. Wiltshire.

Connaught Rooms, W.C.2, 12.30 for 1 p.m. Electrical Industries Club. Luncheon. Guest speaker, Mr. A. L. G. Lindley.

Bonnington Hotel, Southampton Row, W.C.2, 6.30 p.m. Institute of Electricity Administration. "Welfare in the Electricity Supply Industry," by W. M. Booker.

MANCHESTER.—Engineers' Club, Albert Square, 6.15 p.m. I.E.E. North-Western Utilisation Group. Informal discussion on "The Thirteenth Edition of the I.E.E. Wiring Regulations," opened by R. A. Marryat.

YORK.—A.S.E.E. York Branch. Visit to York Sugar Factory.

Wednesday, 14th November

BATH.—Technical College, 7 p.m. I.E.E. Bristol Graduate & Student Section. "Grid Metering," by R. Hawley.

BELFAST.—College of Technology, 7.30 p.m. Belfast Association of Engineers. "Nuclear Power Stations," by G. F. Kennedy.

BIRMINGHAM.—James Watt Institute, Great Charles Street, 6.30 p.m. I.E.E. South Midland Graduate & Student Section. Film evening.

GLASGOW.—39, Elmbank Crescent, 8 p.m. A.S.E.E. Glasgow Branch. "Fire Protection," by A. Chadwick.

ISLEWORTH.—I.E.E. London Graduate & Student Section. Visit to Mining Research Establishment (National Coal Board Laboratories), at 2.30 p.m.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Radio & Telecommunication Section. "Frequency Diversity in the Reception of Selectively Fading Binary Frequency-Modulated Signals with special reference to Long-Distance Radiotelegraphy," by J. W. Allnatt, E. D. J. Jones and H. B. Law; "An Investigation of the Spectra of Binary Frequency-Modulated Signals with Various Build-up Waveforms," by J. W. Allnatt and E. D. J. Jones; "An Improved Fading Machine," by H. B. Law, F. J. Lee, F. A. W. Levitt, and R. C. Looser; "The Detectability of Fading Radiotelegraph Signals in Noise," by H. B. Law, and "The Signal-Noise Performance Rating of Receivers for Long-Distance Synchronous Radiotelegraph Systems using Frequency Modulation," by H. B. Law.

Anatomy Theatre, University College, Gower Street, W.C.1, 7.30 p.m. Radar Association. "Infra Red: its Problems and Possibilities," by Dr. F. E. Jones.

MANCHESTER.—College of Science & Technology, 6.30 p.m. Institution of Production Engineers. Sir Alfred Herbert Paper: "The Development of Technological Education in Europe, America and England," by Dr. B. V. Bowden.

NEWCASTLE-UPON-TYNE. — Neville Hall, Westgate Road, 6 p.m. British Institution of Radio Engineers, North Eastern Section. "Some Practical Aspects of Echo Sounding," by A. M. Sutton.

NORTHAMPTON.—College of Technology, 7.15 p.m. Northampton & District Electrical Association. "Peaceful Uses of Atomic Energy," by K. J. Bobin.

OXFORD.—S.E.B., 37, George Street, 7 p.m. I.E.E. district meeting. "Automation and Electronics in Industry," by F. W. Highfield.

PRESTON.—19, Friargate, 7.15 p.m. I.E.E. North Lancashire Sub-Centre. "Age and the Incidence of Fires in Electrical Installations," by L. Gosland.

SALISBURY.—S.E.B., Canal Walk, 6.30 p.m. I.E.E. Southern Centre. Discussion on "Is the Electrical Equipment of the Modern Motor Vehicle Sufficiently Reliable?" opened by Dr. E. A. Watson.

STAFFORD.—Technical College, 7.15 p.m. I.E.E. North Staffs Graduate & Student Section. "Basic Analogue Computing Applied to Control System Synthesis and Analysis," by R. D. Langman.

Thursday, 15th November

CHELMSFORD. — Crompton's Social Hall, 7.30 p.m. Chelmsford Engineering Society. "Railway Electrification," by J. W. Grieve.

DUBLIN.—Trinity College, 6 p.m. I.E.E. Irish Branch. "Swimming Pool Reactors," by Prof. T. E. Nevin.

LIVERPOOL.—9, The Temple, Dale Street, 7 p.m. Institute of Fuel, Merseyside Sub-Section. "Experience with the Heat Pump in Great Britain," by Miss M. V. Griffith. (Joint meeting with the Liverpool Engineering Society.)

LONDON.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Utilisation Section. "A Self-Oscillating Induction Motor for Shuttle Propulsion," by E. R. Laithwaite and P. J. Lawrenson, and "Brushless Variable-Speed Induction Motors," by Prof. F. C. Williams, E. R. Laithwaite and L. S. Piggott.

MANCHESTER. — N.W.E.B., Town Hall. I.E.S. Manchester Centre. "School Lighting, Part II," by F. Ainscow and J. M. McEwing.

SITTINGBOURNE.—Coniston Hotel, 8 p.m. A.S.E.E. Kent Branch. Film show.

SOUTHAMPTON.—Polygon Hotel, 8 p.m. A.S.E.E. Southampton Branch. "Transistors and their Applications," by R. R. Betteridge.

Friday, 16th November

HANLEY.—Grand Hotel. A.S.E.E. Stoke & Crewe Branch. Annual dinner.

LEEDS.—Queen's Hotel, 7 for 7.30 p.m. I.E.E. North Midland Centre. Annual dinner.

LONDON.—Savoy Hotel, W.C.2, 6.30 p.m. Association of Electrical Machinery Trades. Annual dinner and dance.

Pepys House, 14, Rochester Row, 7 p.m. Junior Institution of Engineers. "Semi-Conductors and their Applications," by R. A. Hill.

Feathers Hotel, Broadway, S.W.1, 6.30 p.m. Electrical Trades' Commercial Travellers' Association. Annual general meeting.

MANCHESTER.—Grand Hotel. Incorporated Plant Engineers, Manchester Branch. Annual dinner.

NEWCASTLE-UPON-TYNE. — King's College, 6.30 p.m. I.E.E. North Eastern Graduate & Student Section. "The Electrolytic Tank and its Applications to Design Problems," by P. F. Kennedy.

Tilley's Restaurant. North East Electrical Club. Annual dinner.

At the Mining Institute, 6.15 p.m. North East Coast Institution of Engineers & Shipbuilders. "Some Safety Considerations of Nuclear Power Reactors," by C. D. Boadle.

Saturday, 17th November

LONDON. — I.E.E. London Graduate & Student Section. Visit to Signalling School, Clapham Junction, at 2.30 p.m.

A.S.E.E. North London Branch. Visit to Arthur Guinness, Son & Co., Ltd., Park Royal Brewery, at 2.15 p.m.

Waldorf Hotel, Aldwych. Incorporated Plant Engineers, London Branch. Annual dinner and dance.

OXFORD.—Regents Park College, Pusey Street, 6.30 p.m. A.S.E.E. Oxford, Reading & Districts Branch. "The 13th Edition of the I.E.E. Rules," by J. J. Looker.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Burma.—Union Purchase Board. 14th November. 200 fluorescent lamp tubes. (E.S.B. 27473/56. Ten/22308.)* Copper wire. (E.S.B. 27471/56. Ten/22323.)* Enamelled copper wire. (E.S.B. 27429/56. Ten/22324.)*

East Grinstead.—U.D.C. 12th December. Electrical installations in 96 houses on the Brooklands estate. (See this issue.)

Formosa.—Central Trust of China, Purchasing Department. 3rd December. Insulators, cables, etc. (E.S.B. 27684/56. I.C.A. Ten/22391.)*

India.—Bombay Electricity Board. 27th November. Two cooling towers for Utran power house. (E.S.B. 27306/56. Ten/22342.)*

Director General of Supplies and Disposals. 27th November. Copper conductors. (E.S.B. 27545/56. Ten/22343.)* 30th November. Lead sleeves for jointing lead sheathed cables. (E.S.B. 27255/56. Ten/22272.)*

Government of Madras. 30th November. Insulators and accessories for 66 kV line. (E.S.B. 27397/56. Ten/22349.)*

Ipswich.—Borough Council. 28th November. Street lighting equipment. (See this issue.)

Iraq.—Directorate General of Municipalities. 23rd February, 1957. Electrical installation in connection with the Ramadi water supply scheme. (E.S.B. 27574/56. Ten/22395.)*

New Zealand.—Auckland Electric Power Board. 23rd November. L.v. cable. (E.S.B. 27165-6/56. Ten/22263-4.)* H.v. cable. (E.S.B. 27163/56. Ten/22262.)*

General Post Office. 28th November. 72 electric fans. (E.S.B. 27261/56. Ten/22284.)* 29th November. 4,200 capacitors. (E.S.B. 27487/56. Ten/22336.)*

Northern Ireland.—Northern Ireland Hospitals Authority. 28th November. Electrical installation in central kitchen, canteen, and recreation hall of Purdysburn Hospital. J. McCandless, consulting engineer, 6, Murray Street, Belfast.

3rd December. Electrical installation in the new church, Creggan, Londonderry. J. A. Kenny & Partners, 44, Kildare Street, Dublin, C.17.

Nottinghamshire.—County Council. 30th November. Street lighting for East Retford by-pass and Markham Moor island. (See this issue.)

Philippines.—National Power Corporation, Manila. 20th November. Power transformer, switchgear and substation equipment. (E.S.B. 27675/56. Ten/22393.)*

South Africa.—Stores Department, South African Railways. 21st November. Electric cable and cable boxes. (E.S.B. 27327/56. Ten/22291.)* Cable. (E.S.B. 27211/56. Ten/22373.)* 23rd November. Telegraph line material. (E.S.B. 27285/56. Ten/22312.)* Cable. (E.S.B. 27324/56. Ten/22279.)* Telephone cable and copper wire. (E.S.B. 27325/56. Ten/22278.)* 28th November. Fluorescent fittings. (E.S.B. 27613/56. Ten/22366.)* 7th December. Overhead track equipment fittings. (E.S.B. 27615/56. Ten/22377.)*

Spain.—Cia. Sevillana de Electricidad. 15th November. Aluminium conductors and accessories. (E.S.B. 27479/56.I.C.A. Ten/22347.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

United States.—Bureau of Reclamation. 4th December. Auto-transformer. (E.S.B. 27205/56. Ten/22374.)*

Wiltshire.—County Council. 12th December. Electrical installation in the workshop block at Trowbridge Area College of Further Education. P. A. Selborne Stringer, clerk, County Hall, Trowbridge.

ORDERS PLACED

Durham.—County Education Committee. Electrical installation at the new Billingham North Roseberry Road County Junior School (£1,683).—B. French.

Glasgow.—Corporation Municipal Transport Committee. Overhead trolley-bus equipment for the conversion of tram service No. 7 and part of tram service No. 12 (£122,600).—Clough, Smith & Co.

Corporation Education Committee. Electrical installation work at the secondary school at Castlemilk, Site No. 8 (£17,209).—James Kilpatrick & Son.

Leeds.—City Council. Recommended. Electrical installations in 144 dwellings at the Cow Close and Intake Lane estates (£3,401).—Hall & Stinson.

Electrical installation in the regional radiotherapy centre at Cookridge Hospital, Otley Old Road (£10,557).—Vallance & Davison.

London.—St. Pancras Borough Council. Street lighting improvements in various roads in the borough (£15,955).—Concrete Utilities.

Sheffield.—Regional Hospital Board. Electric lighting and auxiliary services in ward block 2, at the City General Hospital (£3,358).—Redfern, Ltd. Switchgear at the Fir Vale Infirmary, Sheffield (£2,728).—A. Reyrolle & Co.

Whitehaven.—Newcastle Regional Hospital Board. External electrical services for the proposed new hospital to be erected at Homewood (£5,945).—F. H. Wheeler & Co.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Basingstoke.—Factory extensions, Coronation Road; Electrical, Steam and Mining Equipment (London), Ltd., 60, Fursecroft, George Street, London, W.1.

Birkenhead.—Block of offices in Cleveland Street for Borough Treasurer's Department (£120,000); borough architect, 3, Conway Street.

Birmingham.—Multi-storey shop and office block, Bull Street corner site, for Pearl Assurance Co., Ltd.; S. N. Cooke & Partners, architects, 34, Harborne Road, Edgbaston, Birmingham, 15.

Bothwell (Lanarkshire).—Factory for the Belmos Co., Bellshills.

Brentwood.—Secondary girls' school, Brentwood South (£95,000); H. Conolly, Essex county architect, County Hall, Chelmsford.

Bristol.—Reconstruction of Guildhall with additional buildings (£125,000); J. B. Bennett, city engineer, 470, Bath Road, 4.

Office block; Bristol United Breweries, Ltd., Lewins Mead.

Burnley.—Flats (44), Far Brunshaw estate; borough engineer, 22-24, Nicholas Street.

Colchester.—Dwellings (150), Prettygate estate; borough architect.

Coventry.—Development of Block "J" at City Centre, comprising shops, ballroom, etc.; A. G. Ling, city architect, Bull Yard, off Warwick Row.

Cumberland.—Primary school at Abbey Town; county architect, Portland Square, Carlisle.

New library headquarters at Whitehaven; county architect, Portland Square, Carlisle.

Dartford.—Flats (60), Temple Hill; Thomas Armstrong, town clerk, High Street.

Dunstable.—Two blocks of shops and flats, Brewers Hill estate; borough surveyor.

Farnham.—Laboratory block for Forestry Commission Research Station; J. B. F. Cowper & Poole, architects, 39, Gordon Square, London, W.C.1.

Felling.—Swimming baths for the U.D.C. (£130,000); J. H. Napper, architect, 56, Eldon Place, Newcastle-on-Tyne.

Gateshead.—R.C. church and presbytery, Watson Street; Reavell & Cahill, Lloyds Bank Chambers, Alnwick.

Glasgow.—Conversions at Langside tramway depot to form motor bus garage (£49.000); Architects' Department, Municipal Buildings, George Square.

Godalming.—Milford county secondary school (£102,037); J. Harrison, Surrey county architect, County Hall, Kingston-on-Thames.

Grantham.—Three new wards, nurses' home and other extensions to the Hospital (£200,000); Sheffield Regional Hospital Board, Sheffield.

Great Yarmouth.—Two-storey classroom extension block and other buildings at Salisbury Road Grammar School; F. Jackson, schools architect, 22, Euston Road.

Harrow.—Supermarket, Station Road; Premier Supermarkets, Ltd., Tavistock Place, London, W.C.1.

Hemel Hempstead.—Factory and offices; Dexion, Ltd., 67, Maygrove Road, London, N.W.6.

Jarrow.—Houses (91), Calf Close Lane estate; borough engineer.

Llandudno.—Hotel and catering school at Mostyn Broadway/Gwynedd Road corner site, and fire station at Mostyn Broadway; W. Lloyd Jones, county architect, County Offices, Caernarvon.

London.—Shops and offices, 59-67, Theobald's Road, Holborn; John D. Morgan, architect, 6, Charterhouse Square, E.C.1.

Dwellings (317), Boothby Road area, Islington; Rowley Bros., Ltd., builders, Dunloe Avenue, N.17.

Factory, Domingo Street, Islington; J. Hunnex & Sons, Ltd., 35, Parkhouse Street, S.E.5.

Dwellings (60), Denmark Road, South Norwood; Hawker Smith, Ltd., builders, 1, West Street, Erith.

Primary school, Tulse Hill; J. & C. Bowyer, Ltd., builders, Haynes Lane, S.E.19.

Maidenhead.—Two-storey additions to premises; Vandervell Products, Ltd., Cox Green Road.

Manchester.—Showrooms, Travis Street and Croft Street; R. & R. Autos, Ltd., 232, Stockport Road.

Mansfield.—Houses (169), Westfield Lane; Butterley Co., Ltd., Ripley, near Derby.

Newcastle-on-Tyne.—Additions to Newcastle General Hospital (£70,000); chief architect, Newcastle Hospital Board, Benfield Road.

Factory, Condercum Road, for E. R. Hudspith; M. Gatoff, architect, 25, Trafalgar Street.

Works, Forth Bank; Clodol Industries, Ltd., 37, Lovaine Place.

New Forest.—Houses (62), Hythe; R.D.C. surveyor, Appletree Court, Lyndhurst.

Sheffield.—Shops (25), with maisonnettes, Birley Spa Lane/Main Street sites; Ravenseft Properties, Ltd., 52, Charles Street, London, W.1.